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# REPORT

ON

# MINERAL INDUSTRIES

IN

# THE UNITED STATES

AT THE

## ELEVENTH CENSUS: 1890.

DAVID T. DAY,
SPECIAL AGENT.

WASHINGTON, D. C.:
GOVERNMENT PRINTING OFFICE.
1892.

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# LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
CENSUS OFFICE,
WASHINGTON, D. C., October 4, 1891.

SIR:

I have the honor to transmit herewith all the statistical tables and text which will comprise the final volume of the statistics of the mineral industries in the United States as returned by the Eleventh Census. This report has been prepared under the direction of Dr. David T. Day, special agent in charge, by a corps of experts selected solely because of their familiarity with the subject allotted them for inquiry. The result has proved most satisfactory. All the reports were completed on time, at a cost of several thousand dollars less than the original estimated cost of this branch of the work. The report, as a whole, is undoubtedly the most thorough and complete exhibit of our vast mineral resources ever published, and reflects great credit on its compilers. The ability, energy, and care exercised by Dr. Day and his expert collaborators in the preparation of this volume have not only made it one of the most valuable of the Eleventh Census reports, but it is the first of the final volumes ready for the printer.

I have the honor to be, sir, respectfully, yours,

ROBERT P. PORTER,
*Superintendent of Census.*

Hon. JOHN W. NOBLE,
*Secretary of the Interior.*

# LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
CENSUS OFFICE,
WASHINGTON, D. C., October 3, 1891.

SIR:

On July 18, 1889, I was designated by you as special agent to organize and carry out the investigation into the mining industries for the Eleventh Census. I have the honor to transmit herewith the final report on that subject, entitled "Mineral Industries in the United States".

In transmitting this report I beg that you will accept my hearty thanks for the consideration which you have given to the many demands upon your time and attention, and I wish particularly to express my gratification for the freedom which you have given me in the selection of the experts through whose efforts this report was made possible.

Very respectfully, your obedient servant,

DAVID T. DAY,
*Special Agent in charge of Mines and Mining.*

Hon. ROBERT P. PORTER,
*Superintendent of Census, Washington, D. C.*

# INTRODUCTION.

SCOPE.—This volume is the result of an investigation simply of the position of the mineral industries among the various forms of industrial activity in the United States. It shows the extent of the industry, measured by the quantity and value of the minerals produced, by the amount of capital at stake in the various mining enterprises, and, more particularly, by the extent to which it affords a means of livelihood to the people of the United States. In considering even these few subjects by the census method, in a country of such vast proportions as the United States, the necessary economy of time and money required sharp limitations with each subject.

The inquiry therefore did not extend to the personnel of mining communities. In short, the effort is made to show:

(1) The minerals actually produced.

(2) The industrial features of capital and wages involved in this production.

(3) The number of persons who obtained a living from this product and their usual rates of payment.

Only the persons who gained a livelihood in direct connection with the mines were considered. It was of course impossible to get accurate returns of the large number of prospectors or of the labor cost which they would add if considered in the expenses of mining.

The forms of questions for obtaining this information will be found in the appendix.

The resources still underground but not drawn upon have been omitted, as not pertinent to a census primarily of the population. The peculiarities of race, age, financial welfare, disease, or accident are questions too complicated to be applied to the entire country within reasonable time; further, the conditions of mining are, in important cases, too experimental to furnish any data valuable in efforts for the improvement of these conditions. In cases, however, where the mining possibilities of a certain industry have been thoroughly studied and the information could be obtained by other means than the necessarily expensive census method they have been used. A case in point is the production of quicksilver, an industry which, brought from insignificant beginnings to an important position in the world's supply, has passed that stage and has now declined again. The opportunity has here been embraced to show what may be expected for miners employed for a long time at American wages and under the conditions of taking a store of natural wealth from the ground until it gradually becomes impoverished. The chapter on this subject shows more exactly than could be done by a generalization from many mines the vast amount of persistent, enterprising prospecting in barren ground to find the ore supplies, the necessary development work and its machinery, the methods of ore extraction, the ventilation and drainage, and the optional and enforced social and hygienic conditions among the miners.

The subjects taken for the investigation included all minerals which would have a definite market value wherever they occur, provided the deposit contained the mineral in sufficiently pure form. This ruled out such minerals as ice, water (except mineral waters), sand for street paving, and other materials the condition of which is not changed, but which are simply made valuable by the work of placing in a special position, as earth for embankments.

In the treatment of the various subjects the limit of the mining features was considered as reached when the product became a regular article of commerce. The copper investigation considered the production as far as ingot copper without regard to the subsequent manufacture into sheet copper, castings, etc. Similarly, the inquiry into the precious metals was carried to the stage of the production of metallic gold and silver. In the case of iron ores it is customary to consider the ores themselves as articles of commerce, and the production of metallic iron is considered a separate industry. A necessary inconsistency is introduced in summing up the total value of the mineral products where the total value of the pig iron product is taken, because, from usage, a total value at any other stage would be less intelligible.

ORGANIZATION.—In distinction to allotting a definite section of the domain to an individual for the purpose of dividing the work and expecting this individual to collect the information for all minerals within his section the division was made by separate minerals. This was done because men could not be found equally well informed concerning all minerals. It was possible to find a man specially informed in regard to one industry, even for the entire country, because of the similar work done by the statistical organization in the United States geological survey. The following gentlemen were accordingly placed in charge of their respective subjects:

Mr. John Birkinbine, Philadelphia, Pennsylvania—Iron ore.
Mr. R. P. Rothwell, New York, New York—Gold and silver.
Mr. C. Kirchhoff, New York, New York—Copper and lead and zinc.
Hon. J. B. Randol, San Francisco, California—Quicksilver.
Dr. Charles A. Ashburner, (a) Pittsburg, Pennsylvania, and Mr. John H. Jones, Philadelphia, Pennsylvania—Coal.
Dr. William C. Day, Swarthmore College, Pennsylvania—Stone.
Mr. Joseph D. Weeks, Pittsburg, Pennsylvania—Manganese, petroleum, and natural gas.
Mr. E. W. Parker, Austin, Texas—Minor minerals (those unassigned to other agents).
Mr. George F. Kunz, New York, New York—Precious stones and diamond cutting.
Dr. A. C. Peale, Washington, District of Columbia—Mineral waters.

After the preceding organization was perfected the subject of aluminum was assigned to Dr. R. L. Packard and mica to Mr. Lyman J. Childs.

The schedules of questions to be answered concerning the mineral product, its value, the payments for labor and other expenditures, the capital, and the number of employés were modified as far as necessary for the different industries. These schedules of inquiry were transmitted to the special agents in charge of individual industries, who collected the information from the producers and transmitted the completed reports to the special agent in charge.

METHOD OF COLLECTING INFORMATION.—The problem of securing returns from about 30,000 productive establishments and of determining accurately that fully twice as many more were unproductive, and involving in all the entire area of the United States, is difficult from many considerations, but especially from the fact that the confidential character of the replies is seldom understood, and because the actual records are frequently very incomplete for even the simple inquiry attempted. The method must be more or less modified to suit the subject treated and the localities concerned. The method adopted, and which can be recommended, was to spend a considerable amount of time and money in compiling from all records a directory of the mines before any requests for statistical information were distributed. This work did not present the insuperable difficulties apprehended by many experts. After separating duplicate mines as far as possible, the schedules were distributed to the producers, so that an opportunity was offered them, as in the case of the population schedule, of answering at their convenience and without the annoyance of an interview. More schedules were returned by this correspondence method than was expected. Meantime a corps of visiting special agents was organized, and when their work had been reduced to a minimum by correspondence they were furnished with lists of the delinquents and those whose returns were unsatisfactory. They then visited the producing districts, added the names of such new producers as were found, and finally compared the tabulated returns with the statements by other authorities to determine the reason for any existing discrepancies.

In two regions, viz, the Rocky mountains and the Pacific coast, the difficulty of access to the mines made the work of visiting special agents particularly difficult; hence early in the investigation Mr. Frederic F. Chisolm was appointed to supervise the work of the visiting agents in the Rocky mountain region and to act as the personal representative of the special agent in charge, except in the gold and silver investigation, and Mr. Charles G. Yale was similarly appointed for the Pacific coast.

The subagents engaged in collecting the statistics of the various subjects were as follows:

Iron ore—Messrs. F. L. Bitler and J. M. McMahon.

Gold and silver—Mr. William Kent, chief assistant; eastern states, Messrs. S. W. Cramer and R. H. Wilkinson; Alaska, Mr. J. H. Burfeind; Arizona, Messrs. S. C. Bagg, J. F. Blandy, and William O. O'Neill; California, Messrs. Stephen Barton, G. M. Beatty, A. S. Bent, M. H. Burnham, F. M. Campbell, J. H. Connell, J. H. Crossman, Henry De Groot, R. L. Dunn, J. M. Fisher, F. G. Hail, G. W. Kemble, W. S. Lowden, G. W. Merritt, C. H. Mitchell, J. E. Parker, W. B. Parker, E. F. Southern, W. T. Turner, Samuel Tyler, and Charles G. Yale; Colorado, Messrs. R. M. Cash, F. F. Chisolm, C. J. Eldredge, F. G. Foreshaw, Henry Fulton, J. B. Gilchrist, F. J. Hood, J. S. Lawrence, John Livezey, William McCabe, J. G. Paine, N. B. Quick, I. G. True, C. Van Timmons, H. R. Wagner, W. L. J. Warren, Albert Williams, jr., H. W. Woodward, Carl Wulsten, and C. E. Zelle; Idaho, Messrs. J. S. Childs, M. H. Joseph, and R. L. Packard; Michigan, Mr. F. B. Phelps; Montana, Messrs. Spruille Braden, W. S. Kelly, W. F. Wheeler, R. T. Woliston, and Andrew Young; Nevada, Messrs. James Delavan, M. H. Joseph, George Nicholl, and H. R. Wagner; New Mexico, Mr. J. R. Johnson; Oregon, Mr. W. H. Hampton; South Dakota, Mr. James Long, jr.; Texas, Mr. F. W. Taylor; Utah, Mr. W. G. Van Horne; Washington, Mr. W. H. Hampton; Wyoming, Mr. R. W. Burkhardt.

Copper and lead and zinc—Missouri, Mr. J. A. Zook; Wisconsin, Mr. James Freeman.

Quicksilver—Messrs. F. S. Rice and Fred. Von Leicht.

Tin—Mr. Samuel Scott.

Manganese, petroleum, and natural gas—Mr. A. L. Feldmann.

Coal—In the Philadelphia office, Messrs. J. W. Alder, Baird Halberstadt, J. N. Pott, and John Totty; Alabama, Mr. H. S. Livingood; Arkansas, Mr. C. R. Claghorn; Colorado, Messrs. J. S. Buchanan, J. A. Crawford, W. A. Raborg, and J. C. Weston; Illinois, Messrs. Elisha Beadle, Quintin Clark, James Freer, Walton Rutledge, and Reuben Street; Indiana, Mr. Thomas McQuade; Iowa, Messrs. Thomas Binks, James Gildroy, and M. G. Thomas; Kansas, Messrs. James Gray and J. T. Stewart; Kentucky, Mr. J. C. Norwood; Maryland, Mr. Theophilus George; Michigan, Mr. William Dickinson; Missouri, Mr. B. E. Bloom; Montana, Mr. O. C. Mortson; New Mexico, Messrs. I. M. Bond, Robert Carter, and H. S. Lutz; North Dakota, Mr. R. M. Tuttle; Ohio, Messrs. Alexander Johnson, J. W. Kail, and J. L. Morris; Pennsylvania, Messrs. W. H. Barnhart, J. W. Books, H. J. Boyde, J. O. Edelblute, A. W. Feely, W. W. Fiscus, M. W. Jenkins, T. J. Lee, J. E. Menges, A. B. Miller, W. L. Owens, S. D. Patterson, I. F. Piersol, George Scheffner, E. C. Weaver, and J. H. Westcoat; Tennessee, Mr. H. E. Colton; Utah, Mr. K. C. Kerr; Virginia and West Virginia, Mr. H. A. Wilbourne; Wyoming, Mr. T. J. Bouton.

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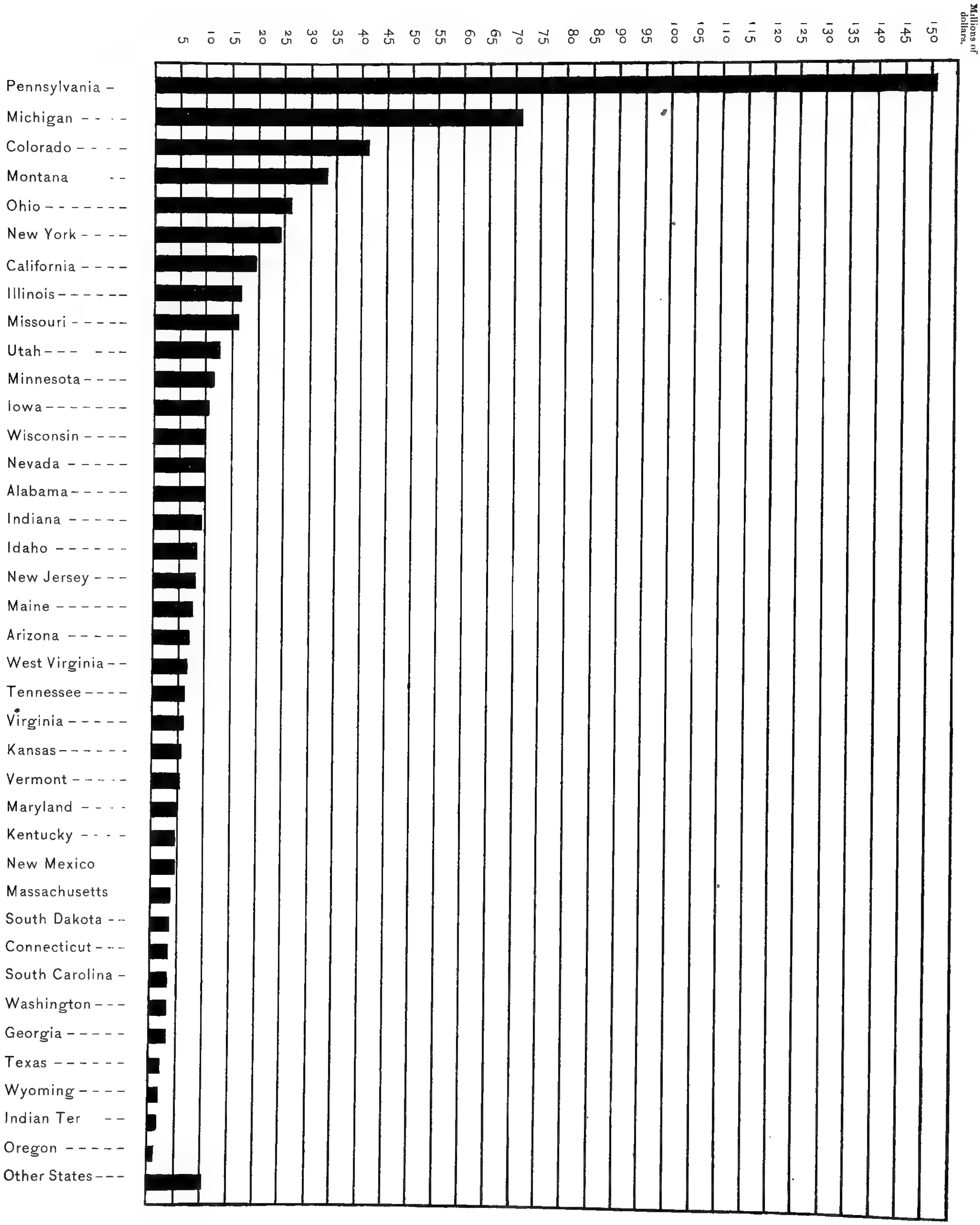
[a] Dr. Ashburner died early in the investigation. He gave most valuable aid in determining the scope of the work and in formulating the schedules of inquiry, and this at a time when his work in other directions was very exhausting, fatally so. The investigation was then completed under the sole direction of Mr. Jones.—D. T. DAY.

Eleventh Census of the United States.



Robert P. Porter, Superintendent.

Stone—Messrs. M. H. Bancroft, E. M. L. Bates, Arthur Beardsly, G. F. Bird, J. T. Cushing, Hasbrouck Davis, T. J. Dolphin, Morris Ebert, C. H. Elliott, R. D. Emslie, J. G. Falck, I. P. Fell, C. H. Hardon, G. A. Hoadley, J. H. Humphries, Harry C. Jones, G. H. Knight, G. C. Koyl, L. M. Kuhns, Eugene Leamy, J. L. Midwood, W. R. Orndorff, G. W. Reese, G. J. Roote, Benjamin Smith, M. M. Smith, W. B. Smith, W. D. Stearns, G. E. Weaver, and E. W. Yarnall.

Mineral waters—Messrs. James Reay and C. H. Richmond.

RESULTS.—The work which has been done annually by different authorities left little doubt that the statistics of production could be obtained with a satisfactory degree of accuracy, although the work of ascertaining the total product by the census method (returns from every producer) is not the usual one, and, indeed, owing to its considerable cost, has not been attempted for all mineral industries since the Tenth Census. The results have proved generally good, and while only in isolated cases has the census method led to very surprising results respecting the total product, still the results may be accepted as confirming the statistics previously collected, rather than depending upon the previous work for establishing the accuracy of the census. A base work of considerable value is therefore established, which will be useful for years. In the direction of distributing the product to the states in which it was produced a great gain has been made. It is unnecessary to call attention to the fact that minerals taken from the ground in one state often first become known to statisticians after treatment in a remote refinery.

The statistics of the employment of labor in mining is practically a new inquiry. No great difficulty was found in obtaining fairly good results, except in very minor operations, in which no records were kept. In all, 636,419 persons found employment directly in the mining industry, and depended upon this industry as their regular means of support. They received in wages $265,290,643, or more than 52 per cent of the entire value of what they produced. In addition, the other expenditures aggregated $115,874,135. It should be noted that the amounts specified for each industry as expended in payments for wage accounts are the actual sums paid, as shown by the pay rolls. An entirely independent statement was obtained, designed to show the usual rates of wages prevalent in the different sections of the country. The result of computing the total wages paid from the usual rates of wages and the total number employed will obviously not agree necessarily with amounts recorded in the books as actually paid.

The statistics as to capital involved in the mining industry are naturally the least accurate, for the estimate of what the property would bring in the market, if offered for sale, must depend on many chance conditions; but the results thoroughly fulfill their purpose in giving an approximate idea of the extent to which the industry is changing from a speculative to a more conservative pursuit, involving an outlay of over $1,340,000,000.

TOTAL VALUE OF THE MINERAL PRODUCTS OF THE UNITED STATES, BY STATES AND TERRITORIES.

| | |
|---|---|
| Total | $587,230,662 |
| Alabama | 9,828,369 |
| Alaska | 926,568 |
| Arizona | 7,248,717 |
| Arkansas | 567,683 |
| California | 19,699,354 |
| Colorado | 41,126,610 |
| Connecticut | 3,090,161 |
| Delaware | 506,754 |
| District of Columbia | 40,000 |
| Florida | 138,728 |
| Georgia | 2,988,935 |
| Idaho | 8,385,233 |
| Illinois | 17,110,317 |
| Indiana | 9,704,949 |
| Indian territory | 1,333,807 |
| Iowa | 10,267,068 |
| Kansas | 5,935,981 |
| Kentucky | 4,711,944 |
| Louisiana | 480,000 |
| Maine | 8,126,493 |
| Maryland | 5,089,447 |
| Massachusetts | 3,700,634 |
| Michigan | 70,880,524 |
| Minnesota | 11,542,138 |
| Mississippi | 41,174 |
| Missouri | 15,931,575 |
| Montana | 33,737,775 |
| Nebraska | $257,019 |
| Nevada | 10,143,874 |
| New Hampshire | 920,164 |
| New Jersey | 8,275,936 |
| New Mexico | 4,611,764 |
| New York | 24,165,206 |
| North Carolina | 451,625 |
| North Dakota | 61,431 |
| Ohio | 26,653,439 |
| Oregon | 1,238,114 |
| Pennsylvania | 150,876,649 |
| Rhode Island | 987,055 |
| South Carolina | 3,022,285 |
| South Dakota | 3,685,862 |
| Tennessee | 6,455,283 |
| Texas | 1,985,679 |
| Utah | 11,681,019 |
| Vermont | 5,674,022 |
| Virginia | 6,023,076 |
| Washington | 2,998,355 |
| West Virginia | 6,969,804 |
| Wisconsin | 10,183,861 |
| Wyoming | 1,810,515 |
| Mexican lead smelted in the United States | 2,343,474 |
| Undistributed copper | 389,273 |
| Nickel in imported Canadian matte | 21,000 |
| Copper from imported pyrites | 603,940 |
| Fuel displaced by natural gas used at pipe lines for drilling and pumping wells and for other uses | 1,600,000 |

MINERAL PRODUCTS OF THE UNITED STATES FOR

| | PRODUCTS. | 1880. | | 1881. | |
|---|---|---|---|---|---|
| | | Quantity. | Value. | Quantity. | Value. |
| | Grand total | | $369, 319, 000 | | $406, 175, 552 |
| | Total value of metallic products | | 190, 039, 865 | | 192, 892, 408 |
| | Total value of nonmetallic mineral products | | 173, 279, 135 | | 206, 783, 144 |
| | Total value of mineral products unspecified | | 6, 000, 000 | | 6, 500, 000 |
| | METALLIC: | | | | |
| 1 | Pig iron, value at Philadelphia, long tons | 3, 375, 912 | 89, 315, 569 | 4, 144, 254 | 87, 029, 334 |
| 2 | Silver, coining value, troy ounces (*b*) | 30, 320, 000 | 39, 200, 000 | 33, 077, 000 | 43, 000, 000 |
| 3 | Gold, coining value, troy ounces (*c*) | 1, 741, 500 | 36, 000, 000 | 1, 676, 300 | 34, 700, 000 |
| 4 | Copper, value at New York city, pounds (*d*) | 60, 480, 000 | 11, 491, 200 | 71, 680, 000 | 12, 175, 600 |
| 5 | Lead, value at New York city, short tons | 97, 825 | 9, 782, 500 | 117, 085 | 11, 240, 160 |
| 6 | Zinc, value at New York city, short tons | 23, 239 | 2, 277, 432 | 26, 800 | 2, 680, 000 |
| 7 | Quicksilver, value at San Francisco, flasks (*e*) | 59, 926 | 1, 797, 780 | 60, 851 | 1, 764, 679 |
| 8 | Nickel, value at Philadelphia, pounds (*f*) | 329, 968 | 164, 984 | 265, 668 | 292, 235 |
| 9 | Aluminum, value at Pittsburg, pounds | (*g*) | | (*g*) | |
| 10 | Antimony, value at San Francisco, short tons (*h*) | 50 | 10, 000 | 50 | 10, 000 |
| 11 | Platinum, value (crude) at San Francisco, troy ounces | 100 | 400 | 100 | 400 |
| | NONMETALLIC (SPOT VALUES): | | | | |
| 12 | Bituminous coal, long tons (*i*) | 38, 242, 641 | 53, 443, 718 | 48, 179, 475 | 60, 224, 344 |
| 13 | Pennsylvania anthracite, long tons (*j*) | 25, 580, 189 | 42, 196, 678 | 28, 500, 016 | 64, 125, 036 |
| 14 | Building stone | | 18, 356, 055 | | 20, 000, 000 |
| 15 | Petroleum, barrels (*k*) | 26, 286, 123 | 24, 183, 233 | 27, 661, 238 | 25, 448, 339 |
| 16 | Lime, barrels (*l*) | 28, 000, 000 | 19, 000, 000 | 30, 000, 000 | 20, 000, 000 |
| 17 | Natural gas | | (*g*) | | (*g*) |
| 18 | Cement, barrels (*m*) | 2, 072, 943 | 1, 852, 707 | 2, 500, 000 | 2, 000, 000 |
| 19 | Salt, barrels (*n*) | 5, 961, 060 | 4, 829, 566 | 6, 200, 000 | 4, 200, 000 |
| 20 | Limestone for iron flux, long tons | 4, 500, 000 | 3, 800, 000 | 6, 000, 000 | 4, 100, 000 |
| 21 | Phosphate rock, long tons (*o*) | 211, 377 | 1, 123, 823 | 266, 734 | 1, 980, 259 |
| 22 | Mineral waters, gallons sold | 2, 000, 000 | 500, 000 | 3, 000, 000 | 700, 000 |
| 23 | Zinc white, short tons | 10, 107 | 763, 738 | 10, 000 | 700, 000 |
| 24 | Gypsum, short tons | 90, 000 | 400, 000 | 85, 000 | 350, 000 |
| 25 | Borax, pounds | 3, 692, 443 | 277, 233 | 4, 046, 000 | 304, 461 |
| 26 | Mineral paints, long tons (*p*) | 3, 604 | 135, 840 | 6, 000 | 100, 000 |
| 27 | Manganese ore, long tons | 5, 761 | 86, 415 | 4, 895 | 73, 425 |
| 28 | Asphaltum, short tons | 444 | 4, 440 | 2, 000 | 8, 000 |
| 29 | Pyrites, long tons | 2, 000 | 5, 000 | 10, 000 | 60, 000 |
| 30 | Crude barytes, long tons | 20, 000 | 80, 000 | 20, 000 | 80, 000 |
| 31 | Bromine, pounds | 404, 690 | 114, 752 | 300, 000 | 75, 000 |
| 32 | Corundum, short tons (*q*) | 1, 044 | 29, 280 | 500 | 80, 000 |
| 33 | Marls, short tons (*r*) | 1, 000, 000 | 500, 000 | 1, 000, 000 | 500, 000 |
| 34 | Precious stones | | 50, 000 | | 60, 000 |
| 35 | Gold quartz, souvenirs, jewelry, etc | | 50, 000 | | 50, 000 |
| 36 | Flint, long tons | 20, 000 | 80, 000 | 25, 000 | 100, 000 |
| 37 | Fluorspar, short tons | 4, 000 | 16, 000 | 4, 000 | 16, 000 |
| 38 | Graphite, pounds | | [s] 49, 800 | 400, 000 | 30, 000 |
| 39 | Novaculite, pounds | 420, 000 | 8, 000 | 500, 000 | 8, 580 |
| 40 | Feldspar, long tons | 12, 500 | 60, 000 | 14, 000 | 70, 000 |
| 41 | Chromic iron ore, long tons | 2, 288 | 27, 808 | 2, 000 | 30, 000 |
| 42 | Mica, pounds | 81, 669 | 127, 825 | 100, 000 | 250, 000 |
| 43 | Slate ground as a pigment, long tons | 1, 000 | 10, 000 | 1, 000 | 10, 000 |
| 44 | Cobalt oxide, pounds | 7, 251 | 24, 000 | 8, 280 | 25, 000 |
| 45 | Sulphur, short tons | 600 | 21, 000 | 600 | 21, 000 |
| 46 | Rutile, pounds | 100 | 400 | 200 | 700 |
| 47 | Asbestos, short tons | 150 | 4, 312 | 200 | 7, 000 |
| 48 | Potters' clay, long tons | 20, 783 | 200, 457 | 25, 000 | 200, 000 |
| 49 | Grindstones | | 500, 000 | | 500, 000 |
| 50 | Millstones | | 200, 000 | | 150, 000 |
| 51 | Ozocerite, refined, pounds | | | | |
| 52 | Infusorial earth, short tons | 1, 833 | 45, 660 | 1, 000 | 10, 000 |
| 53 | Soapstone, short tons | 8, 441 | 66, 665 | 7, 000 | 75, 000 |
| 54 | Fibrous talc, short tons | 4, 210 | 54, 730 | 5, 000 | 60, 000 |
| 55 | Lithographic stone, short tons | | | 50 | 1, 000 |

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*a* The statistics for 1880 are mainly revisions of the results of the Tenth Census; those for 1881 are estimates by D. T. Day; from 1882 to 1888 the statistics have been taken from the reports of the United States geological survey, with occasional modifications. The statistics of lime, salt, cement, slate ground as a pigment and rutile in 1889 are estimates by D. T. Day.

*b* $1.2929 per troy ounce.

*c* $20.6718 per troy ounce.

*d* Including copper made from imported pyrites.

*e* Of 76.5 avoirdupois pounds net.

*f* Including nickel in copper-nickel alloy and in exported ore and matte, except for 1881, for which no returns are available for matte.

*g* None reported.

THE CALENDAR YEARS 1880 TO 1889, INCLUSIVE. (*a*)

| 1882. | | 1883. | | 1884. | | |
|---|---|---|---|---|---|---|
| Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | |
| | $457, 595, 259 | | $453, 441, 073 | | $412, 989, 105 | |
| | 219, 755, 109 | | 203, 128, 859 | | 186, 109, 599 | |
| | 231, 340, 150 | | 243, 812, 214 | | 221, 879, 506 | |
| | 6, 500, 000 | | 6, 500, 000 | | 5, 000, 000 | |
| 4, 623, 323 | 106, 336, 429 | 4, 595, 510 | 91, 910, 200 | 4, 097, 868 | 73, 761, 624 | 1 |
| 36, 197, 695 | 46, 800, 000 | 35, 733, 622 | 46, 200, 000 | 37, 744, 605 | 48, 800, 000 | 2 |
| 1, 572, 186 | 32, 500, 000 | 1, 451, 249 | 30, 000, 000 | 1, 489, 949 | 30, 800, 000 | 3 |
| 91, 646, 232 | 16, 038, 091 | 117, 151, 795 | 18, 064, 807 | 145, 221, 934 | 17, 789, 687 | 4 |
| 132, 890 | 12, 624, 550 | 143, 957 | 12, 322, 719 | 139, 897 | 10, 537, 042 | 5 |
| 33, 765 | 3, 646, 620 | 36, 872 | 3, 311, 106 | 38, 544 | 3, 422, 707 | 6 |
| 52, 732 | 1, 487, 042 | 46, 725 | 1, 253, 632 | 31, 913 | 936, 327 | 7 |
| 281, 616 | 309, 777 | 58, 800 | 52, 920 | 64, 550 | 48, 412 | 8 |
| (*g*) | | 83 | 875 | 150 | 1, 350 | 9 |
| 60 | 12, 000 | 60 | 12, 000 | 60 | 12, 000 | 10 |
| 200 | 600 | 200 | 600 | 150 | 450 | 11 |
| 60, 861, 190 | 76, 076, 487 | 68, 531, 500 | 82, 237, 800 | 73, 730, 539 | 77, 417, 066 | 12 |
| 31, 358, 264 | 70, 556, 094 | 34, 336, 469 | 77, 257, 055 | 33, 175, 756 | 66, 351, 512 | 13 |
| | 21, 000, 000 | | 20, 000, 000 | | 19, 000, 000 | 14 |
| 30, 510, 830 | 24, 065, 988 | 23, 449, 633 | 25, 790, 252 | 24, 218, 438 | 20, 595, 966 | 15 |
| 31, 000, 000 | 21, 700, 000 | 32, 000, 000 | 19, 200, 000 | 37, 000, 000 | 18, 500, 000 | 16 |
| | 215, 000 | | 475, 000 | | 1, 460, 000 | 17 |
| 3, 250, 000 | 3, 672, 750 | 4, 190, 000 | 4, 293, 500 | 4, 000, 000 | 3, 720, 000 | 18 |
| 6, 412, 373 | 4, 320, 140 | 6, 192, 231 | 4, 211, 042 | 6, 514, 937 | 4, 197, 734 | 19 |
| 3, 850, 000 | 2, 310, 000 | 3, 814, 273 | 1, 907, 136 | 3, 401, 930 | 1, 700, 965 | 20 |
| 332, 077 | 1, 992, 462 | 378, 380 | 2, 270, 280 | 431, 779 | 2, 374, 784 | 21 |
| 5, 000, 000 | 800, 000 | 7, 529, 423 | 1, 119, 603 | 10, 215, 328 | 1, 459, 143 | 22 |
| 10, 000 | 700, 000 | 12, 000 | 840, 000 | 13, 000 | 910, 000 | 23 |
| 100, 000 | 450, 000 | 90, 000 | 420, 000 | 90, 000 | 390, 000 | 24 |
| 4, 236, 291 | 338, 903 | 6, 500, 000 | 585, 000 | 7, 000, 000 | 490, 000 | 25 |
| 7, 000 | 105, 000 | 7, 000 | 84, 000 | 7, 000 | 84, 000 | 26 |
| 4, 532 | 67, 980 | 6, 155 | 92, 325 | 10, 180 | 122, 160 | 27 |
| 3, 000 | 10, 500 | 3, 000 | 10, 500 | 3, 000 | 10, 500 | 28 |
| 12, 000 | 72, 000 | 25, 000 | 137, 500 | 35, 000 | 175, 000 | 29 |
| 20, 000 | 80, 000 | 27, 000 | 108, 000 | 25, 000 | 100, 000 | 30 |
| 250, 000 | 75, 000 | 301, 100 | 72, 264 | 281, 100 | 67, 464 | 31 |
| 500 | 80, 000 | 550 | 100, 000 | 600 | 108, 000 | 32 |
| 1, 080, 000 | 540, 000 | 972, 000 | 486, 000 | 875, 000 | 437, 500 | 33 |
| | 75, 000 | | 92, 050 | | 82, 975 | 34 |
| | 75, 000 | | 115, 000 | | 140, 000 | 35 |
| 25, 000 | 100, 000 | 25, 000 | 100, 000 | 30, 000 | 120, 000 | 36 |
| 4, 000 | 20, 000 | 4, 000 | 20, 000 | 4, 000 | 20, 000 | 37 |
| 425, 000 | 34, 000 | 575, 000 | 46, 000 | | (*t*) | 38 |
| 600, 000 | 10, 000 | 600, 000 | 10, 000 | 800, 000 | 12, 000 | 39 |
| 14, 000 | 70, 000 | 14, 100 | 71, 112 | 10, 900 | 55, 112 | 40 |
| 2, 500 | 50, 000 | 3, 000 | 60, 000 | 2, 000 | 35, 000 | 41 |
| 100, 000 | 250, 000 | 114, 000 | 285, 000 | 147, 410 | 368, 525 | 42 |
| 2, 000 | 24, 000 | 2, 000 | 24, 000 | 2, 000 | 20, 000 | 43 |
| 11, 653 | 32, 046 | 1, 096 | 2, 795 | 2, 000 | 5, 100 | 44 |
| 600 | 21, 000 | 1, 000 | 27, 000 | 500 | 12, 000 | 45 |
| 500 | 1, 800 | 550 | 2, 000 | 600 | 2, 000 | 46 |
| 1. 200 | 36, 000 | 1, 000 | 30, 000 | 1, 000 | 30, 000 | 47 |
| 30, 000 | 240, 000 | 32, 000 | 250, 000 | 35, 000 | 270, 000 | 48 |
| | 700, 000 | | 600, 000 | | 570, 000 | 49 |
| | 200, 000 | | 150, 000 | | 150, 000 | 50 |
| | | | | | | 51 |
| 1, 000 | 8, 000 | 1, 000 | 5, 000 | 1, 000 | 5, 000 | 52 |
| 6, 000 | 90, 000 | 8, 000 | 150, 000 | 10, 000 | 200, 000 | 53 |
| 6, 000 | 75, 000 | 6, 000 | 75, 000 | 10, 000 | 110, 000 | 54 |
| | | | | | | 55 |

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*h* Part of the antimony in 1889 was valued at Philadelphia.

*i* Except in 1880 and 1889 this includes brown coal and lignite and anthracite mined elsewhere than in Pennsylvania.

*j* In 1880 and 1889 this includes all anthracite.

*k* Of 42 gallons.

*l* Of 200 pounds.

*m* Of 300 pounds for natural cement and 400 pounds for artificial Portland.

*n* Of 280 pounds net.

*o* Except for 1889 this represents only the South Carolina product.

*p* Ocher and metallic paint.

*q* Refined corundum from 1881 to 1888, both inclusive.

*r* Except for 1888 and 1889 this includes only New Jersey marls.

*s* Value of the crude product.

*t* Practically nothing.

MINERAL PRODUCTS OF THE UNITED STATES FOR THE

| | PRODUCTS. | 1885. | | 1886. | |
|---|---|---|---|---|---|
| | | Quantity. | Value. | Quantity. | Value. |
| | Grand total | ........ | $427, 898, 680 | ........ | $465, 504, 294 |
| | Total value of metallic products | ........ | 181, 586, 587 | ........ | 215, 364, 825 |
| | Total value of nonmetallic mineral products | ........ | 241, 312, 093 | ........ | 245, 139, 469 |
| | Total value of mineral products unspecified | ........ | 5, 000, 000 | ........ | 5, 000, 000 |
| | METALLIC: | | | | |
| 1 | Pig iron, value at Philadelphia, long tons | 4, 044, 525 | 64, 712, 400 | 5, 683, 329 | 95, 195, 760 |
| 2 | Silver, coining value, troy ounces | 39, 910, 279 | 51, 600, 000 | 39, 445, 312 | 51, 000, 000 |
| 3 | Gold, coining value, troy ounces | 1, 538, 376 | 31, 800, 000 | 1, 881, 250 | 35, 000, 000 |
| 4 | Copper, value at New York city, pounds | 170, 962, 607 | 18, 292, 999 | 161, 235, 381 | 16, 527, 651 |
| 5 | Lead, value at New York city, short tons | 129, 412 | 10, 469, 431 | 135, 629 | 12, 667, 749 |
| 6 | Zinc, value at New York city, short tons | 40, 688 | 3, 539, 856 | 42, 641 | 3, 752, 408 |
| 7 | Quicksilver, value at San Francisco, flasks | 32, 073 | 979, 189 | 29, 981 | 1, 060, 000 |
| 8 | Nickel, value at Philadelphia, pounds | 277, 904 | 179, 975 | 214, 992 | 127, 157 |
| 9 | Aluminum, value at Pittsburg, pounds | 283 | 2, 550 | 3, 000 | 27, 000 |
| 10 | Antimony, value at San Francisco, short tons | 50 | 10, 000 | 35 | 7, 000 |
| 11 | Platinum, value (crude) at San Francisco, troy ounces | 250 | 187 | 50 | 100 |
| | NONMETALLIC (SPOT VALUES): | | | | |
| 12 | Bituminous coal, long tons | 64, 840, 668 | 82, 347, 648 | 65, 810, 676 | 78, 481, 056 |
| 13 | Pennsylvania anthracite, long tons | 34, 228, 548 | 76, 671, 948 | 34, 853, 077 | 76, 119, 120 |
| 14 | Building stone | ........ | 19, 000, 000 | ........ | 19, 000, 000 |
| 15 | Petroleum, barrels | 21, 847, 205 | 19, 198, 243 | 28, 064, 841 | 19, 996, 313 |
| 16 | Lime, barrels | 40, 000, 000 | 20, 000, 000 | 42, 500, 000 | 21, 250, 000 |
| 17 | Natural gas | ........ | 4, 857, 200 | ........ | 10, 012, 000 |
| 18 | Cement, barrels | 4, 150, 000 | 3, 492, 500 | 4, 500, 000 | 3, 990, 000 |
| 19 | Salt, barrels | 7, 038, 653 | 4, 825, 345 | 7, 707, 081 | 4, 736, 585 |
| 20 | Limestone for iron flux, long tons | 3, 356, 956 | 1, 678, 478 | 4, 717, 163 | 2, 830, 297 |
| 21 | Phosphate rock, long tons | 437, 856 | 2, 846, 064 | 430, 549 | 1, 872, 936 |
| 22 | Mineral waters, gallons sold | 9, 148, 401 | 1, 312, 845 | 8, 950, 317 | 1, 284, 070 |
| 23 | Zinc white, short tons | 15, 000 | 1, 050, 000 | 18, 000 | 1, 440, 000 |
| 24 | Gypsum, short tons | 90, 405 | 405, 000 | 95, 250 | 428, 625 |
| 25 | Borax, pounds | 8, 000, 000 | 480, 000 | 9, 778, 290 | 488, 915 |
| 26 | Mineral paints, long tons | 3, 950 | 43, 575 | 15, 800 | 285, 000 |
| 27 | Manganese ore, long tons | 23, 258 | 190, 281 | 30, 193 | 277, 636 |
| 28 | Asphaltum, short tons | 3, 000 | 10, 500 | 3, 500 | 14, 000 |
| 29 | Pyrites, long tons | 49, 000 | 220, 500 | 55, 000 | 220, 000 |
| 30 | Crude barytes, long tons | 15, 000 | 75, 000 | 10, 000 | 50, 000 |
| 31 | Bromine, pounds | 310, 000 | 89, 900 | 428, 334 | 141, 350 |
| 32 | Corundum, short tons | 600 | 108, 000 | 645 | 116, 190 |
| 33 | Marls, short tons | 875, 000 | 437, 500 | 800, 000 | 400, 000 |
| 34 | Precious stones | ........ | 69, 900 | ........ | 79, 056 |
| 35 | Gold quartz, souvenirs, jewelry, etc | ........ | 140, 000 | ........ | 40, 000 |
| 36 | Flint, long tons | 30, 000 | 120, 000 | 30, 000 | 120, 000 |
| 37 | Fluorspar, short tons | 5, 000 | 22, 500 | 5, 000 | 22, 000 |
| 38 | Graphite, pounds | 327, 883 | 26, 231 | 415, 525 | 33, 242 |
| 39 | Novaculite, pounds | 1, 000, 000 | 15, 000 | 1, 160, 000 | 15, 000 |
| 40 | Feldspar, long tons | 13, 600 | 68, 000 | 14, 900 | 74, 500 |
| 41 | Chromic iron ore, long tons | 2, 700 | 40, 000 | 2, 000 | 30, 000 |
| 42 | Mica, pounds | 92, 000 | 161, 000 | 40, 000 | 70, 000 |
| 43 | Slate ground as a pigment, long tons | 1, 975 | 24, 687 | 3, 000 | 30, 000 |
| 44 | Cobalt oxide, pounds | *c*68, 723 | 65, 373 | *c*35, 000 | 36, 878 |
| 45 | Sulphur, short tons | 715 | 17, 875 | 2, 500 | 75, 000 |
| 46 | Rutile, pounds | 600 | 2, 000 | 600 | 2, 000 |
| 47 | Asbestos, short tons | 300 | 9, 000 | 200 | 6, 000 |
| 48 | Potters' clay, long tons | 36, 000 | 275, 000 | 40, 000 | 325, 000 |
| 49 | Grindstones | ........ | 500, 000 | ........ | 250, 000 |
| 50 | Millstones | ........ | 100, 000 | ........ | 140, 000 |
| 51 | Ozocerite, refined, pounds | ........ | ........ | ........ | ........ |
| 52 | Infusorial earth, short tons | 1, 000 | 5, 000 | 1, 200 | 6, 000 |
| 53 | Soapstone, short tons | 10, 000 | 200, 000 | 12, 000 | 225, 000 |
| 54 | Fibrous talc, short tons | 10, 000 | 110, 000 | 12, 000 | 125, 000 |
| 55 | Lithographic stone, short tons | ........ | ........ | 40 | 700 |

*a* Not including lime in barrels, limestone for iron flux or grindstones.

*b* Value of the crude product.

**CALENDAR YEARS 1880 TO 1889, INCLUSIVE—Continued.**

| 1887. |  | 1888. |  | 1889. |  |  |
|---|---|---|---|---|---|---|
| Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |  |
|  | $542,691,374 |  | $564,498,631 |  | $587,230,662 |  |
|  | 250,275,054 |  | 256,257,517 |  | 269,590,487 |  |
|  | 287,416,320 |  | 303,241,114 |  | 307,640,175 |  |
|  | 5,000,000 |  | 5,000,000 |  | 10,000,000 |  |
| 6,417,148 | 121,925,800 | 6,489,738 | 107,000,000 | 7,603,642 | 120,000,000 | 1 |
| 41,269,240 | 53,350,000 | 45,783,632 | 59,195,000 | 51,354,851 | 66,396,988 | 2 |
| 1,596,500 | 33,000,000 | 1,604,927 | 33,175,000 | 1,590,869 | 32,886,744 | 3 |
| 185,227,331 | 21,115,916 | 231,270,622 | 33,833,954 | 231,246,214 | 26,907,809 | 4 |
| 160,700 | 14,463,000 | 180,555 | 15,924,951 | 182,967 | 16,137,689 | 5 |
| 50,340 | 4,782,300 | 55,903 | 5,500,855 | 58,860 | 5,791,824 | 6 |
| 33,825 | 1,429,000 | 33,250 | 1,413,125 | 26,484 | 1,190,500 | 7 |
| 205,566 | 133,200 | 204,328 | 127,632 | 252,663 | 151,598 | 8 |
| 18,000 | 59,000 | 19,000 | 65,000 | 47,468 | 97,335 | 9 |
| 75 | 15,000 | 100 | 20,000 | 115 | 28,000 | 10 |
| 448 | 1,838 | 500 | 2,000 | 500 | 2,000 | 11 |
| 78,470,857 | 98,004,656 | 91,106,998 | 101,860,529 | 85,383,059 | 94,346,809 | 12 |
| 37,578,747 | 84,552,181 | 41,624,611 | 89,020,483 | 40,714,721 | 65,879,514 | 13 |
|  | 25,000,000 |  | 25,500,000 |  | *a*42,809,706 | 14 |
| 28,278,866 | 18,877,094 | 27,612,025 | 17,947,620 | 35,163,513 | 26,963,340 | 15 |
| 46,750,000 | 23,375,000 | 49,087,000 | 24,543,500 | 68,474,668 | 33,217,015 | 16 |
|  | 15,817,500 |  | 22,629,875 |  | 21,097,099 | 17 |
| 6,942,744 | 5,674,377 | 6,503,295 | 5,021,139 | 7,000,000 | 5,000,000 | 18 |
| 7,831,962 | 4,093,846 | 8,055,881 | 4,374,203 | 8,005,565 | 4,195,412 | 19 |
| 5,377,000 | 3,226,200 | 5,438,000 | 2,719,000 | 6,318,000 | 3,159,000 | 20 |
| 480,558 | 1,836,818 | 448,567 | 2,018,552 | 550,245 | 2,937,776 | 21 |
| 8,259,609 | 1,261,463 | 9,578,648 | 1,679,302 | 12,780,471 | 1,748,458 | 22 |
| 18,000 | 1,440,000 | 20,000 | 1,600,000 | 16,970 | 1,357,600 | 23 |
| 95,000 | 425,000 | 110,000 | 550,000 | 267,769 | 764,118 | 24 |
| 11,000,000 | 550,000 | 7,589,000 | 455,340 | 8,000,000 | 500,000 | 25 |
| 20,000 | 310,000 | 24,000 | 380,000 | 32,307 | 463,766 | 26 |
| 34,524 | 333,844 | 29,198 | 279,571 | 24,197 | 240,559 | 27 |
| 4,000 | 16,000 | 53,800 | 331,500 | 51,735 | 171,537 | 28 |
| 52,000 | 210,000 | 54,331 | 167,658 | 93,705 | 202,119 | 29 |
| 15,000 | 75,000 | 20,000 | 110,000 | 19,161 | 106,313 | 30 |
| 199,087 | 61,717 | 307,386 | 95,290 | 418,891 | 125,667 | 31 |
| 600 | 108,000 | 589 | 91,620 | 2,245 | 105,565 | 32 |
| 600,000 | 300,000 | 300,000 | 150,000 | 156,265 | 63,956 | 33 |
|  | 88,600 |  | 64,850 |  | 188,807 | 34 |
|  | 75,000 |  | 75,000 |  |  | 35 |
| 32,000 | 185,000 | 30,000 | 175,000 | 11,113 | 49,137 | 36 |
| 5,000 | 20,000 | 6,000 | 30,000 | 9,500 | 45,835 | 37 |
| 416,000 | 34,000 | 400,000 | 33,000 |  | *b*72,662 | 38 |
| 1,200,000 | 16,000 | 1,500,000 | 18,000 | 5,982,000 | 32,980 | 39 |
| 10,200 | 56,100 | 8,700 | 50,000 | 6,970 | 39,370 | 40 |
| 3,000 | 40,000 | 1,500 | 20,000 | 2,000 | 30,000 | 41 |
| 70,000 | 142,250 | 48,000 | 70,000 | 49,500 | 50,000 | 42 |
| 2,000 | 20,000 | 2,500 | 25,000 | 2,000 | 20,000 | 43 |
| *d*18,340 | 18,774 | *c*8,491 | 15,782 | 13,955 | 31,092 | 44 |
| 3,000 | 100,000 | (*e*) |  | 1,150 | 7,850 | 45 |
| 1,000 | 3,000 | 1,000 | 3,000 | 1,000 | 3,000 | 46 |
| 150 | 4,500 | 100 | 3,000 | 30 | 1,800 | 47 |
| 43,000 | 340,000 | 36,750 | 300,000 | 294,344 | 635,578 | 48 |
|  | 224,400 |  | 281,800 |  | 439,587 | 49 |
|  | 100,000 |  | 81,000 |  | 35,155 | 50 |
|  |  | 43,500 | 3,000 | 50,000 | 2,500 | 51 |
| 3,000 | 15,000 | 1,500 | 7,500 | 3,466 | 23,372 | 52 |
| 12,000 | 225,000 | 15,000 | 250,000 | 12,715 | 231,708 | 53 |
| 15,000 | 160,000 | 20,000 | 210,000 | 23,746 | 244,170 | 54 |
|  |  |  |  | 18 |  |  |

*c* Including that contained in ore and matte.

*d* Including cobalt oxide in exported ore and matte.

## TOTAL MINERAL PRODUCTION OF THE UNITED STATES FROM 1880 TO 1889, INCLUSIVE, WITH VALUES, AMOUNTS, AND PERCENTAGE INCREASE OR DECREASE OF 1889 OVER 1880.

| PRODUCTS. | PRODUCTION FOR 10 YEARS. |  | INCREASE OR DECREASE IN 1889 COMPARED WITH 1880. |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|
|  | Quantity. | Value. | Increase in quantity. | Percentage of increase. | Decrease in quantity. | Percentage of decrease. | Increase in value. | Percentage of increase. | Decrease in value. | Percentage of decrease. |
| Grand total |  | $4, 687, 343, 630 |  |  |  |  | $217, 911, 662 | 59. 00 |  |  |
| Total value of metallic products |  | 2, 165, 000, 310 |  |  |  |  | 79, 550, 622 | 41. 86 |  |  |
| Total value of nonmetallic products |  | 2, 461, 843, 320 |  |  |  |  | 134, 361, 040 | 77. 54 |  |  |
| Total value of mineral products unspecified. |  | 60, 500, 000 |  |  |  |  | 4, 000, 000 | 66. 67 |  |  |
| METALLIC: |  |  |  |  |  |  |  |  |  |  |
| Pig iron, value at Philadelphia, long tons | 51, 075, 249 | 957, 187, 116 | 4, 227, 730 | 125. 23 |  |  | 30, 684, 431 | 34. 36 |  |  |
| Silver, coining value, troy ounces (*a*) | 390, 836, 236 | 505, 541, 988 | 21, 034, 851 | 69. 38 |  |  | 27, 196, 988 | 69. 38 |  |  |
| Gold, coining value, troy ounces (*b*) | 16, 143, 106 | 329, 861, 744 |  |  | 150, 631 | 8. 65 |  |  | $3, 113, 256 | 8. 65 |
| Copper, value at New York city, pounds (*c*). | 1, 466, 122, 116 | 192, 237, 714 | 170, 766, 214 | 282. 35 |  |  | 15, 416, 609 | 134. 16 |  |  |
| Lead, value at New York city, short tons. | 1, 420, 917 | 126, 169, 791 | 85, 142 | 87. 04 |  |  | 6, 355, 189 | 64. 96 |  |  |
| Zinc, value at New York city, short tons | 407, 652 | 38, 705, 108 | 35, 621 | 153. 28 |  |  | 3, 514, 392 | 154. 31 |  |  |
| Quicksilver, value at San Francisco, flasks (*d*). | 407, 760 | 13, 311, 274 |  |  | 33, 442 | 55. 81 |  |  | 607, 280 | 33. 78 |
| Nickel, value at Philadelphia, pounds (*e*) | 2, 156, 055 | 1, 587, 890 |  |  | 77, 305 | 23. 43 |  |  | 13, 386 | 8. 11 |
| Aluminum, value at Pittsburg, pounds | 87, 984 | 253, 110 | 47, 468 |  |  |  | 97, 335 |  |  |  |
| Antimony, value at San Francisco, short tons (*f*). | 655 | 136, 000 | 65 | 130. 00 |  |  | 18, 000 | 180. 00 |  |  |
| Platinum, value (crude) at San Francisco, troy ounces. | 2, 498 | 8, 575 | 400 | 400. 00 |  |  | 1, 600 | 400. 00 |  |  |
| NONMETALLIC (SPOT VALUES): |  |  |  |  |  |  |  |  |  |  |
| Bituminous coal, long tons (*g*) | 675, 157, 603 | 804, 440, 113 | 47, 140. 418 | 123. 27 |  |  | 40, 903, 091 | 76. 53 |  |  |
| Pennsylvania anthracite, long tons (*h*) | 341, 950, 398 | 712, 729, 621 | 15, 134, 532 | 59. 17 |  |  | 23, 682, 836 | 56. 12 |  |  |
| Building stone |  | 229, 665, 761 |  |  |  |  | 24, 453, 651 | 133. 22 |  |  |
| Petroleum, barrels (*i*) | 273, 092, 712 | 223, 066, 388 | 8, 877, 390 | 33. 77 |  |  | 2, 780, 107 | 11. 50 |  |  |
| Lime, barrels (*j*) | 404, 811, 668 | 220, 785, 515 | 40, 474, 668 | 144. 55 |  |  | 14, 217, 015 | 74. 83 |  |  |
| Natural gas |  | 76, 563, 674 |  |  |  |  | 21, 097, 099 |  |  |  |
| Cement, barrels (*k*) | 45, 108, 982 | 38, 716, 973 | 4, 927, 057 | 237. 68 |  |  | 3, 147, 293 | 169. 88 |  |  |
| Salt, barrels (*l*) | 69, 919, 743 | 43, 983, 873 | 2, 044, 505 | 34. 30 |  |  |  |  | 634, 154 | 13. 13 |
| Limestone for iron flux, long tons | 46, 773, 322 | 27, 431, 076 | 1, 818, 000 | 40. 40 |  |  |  |  | 641, 000 | 16. 87 |
| Phosphate rock, long tons (*m*) | 3, 968, 122 | 21, 253, 754 | 338, 868 | 160. 31 |  |  | 1, 813, 953 | 161. 41 |  |  |
| Mineral waters, gallons sold | 76, 462, 197 | 11, 864, 884 | 10, 780, 471 | 539. 02 |  |  | 1, 248, 458 | 249. 69 |  |  |
| Zinc white, short tons | 143, 077 | 10, 801, 338 | 6, 863 | 67. 90 |  |  | 593, 862 | 77. 76 |  |  |
| Gypsum, short tons | 1, 113, 424 | 4, 582, 743 | 177, 769 | 197. 52 |  |  | 364, 118 | 91. 03 |  |  |
| Borax, pounds | 69, 842, 024 | 4, 469, 852 | 4, 307, 557 | 116. 66 |  |  | 222, 767 | 80. 35 |  |  |
| Mineral paints, long tons (*n*) | 126, 661 | 1, 991, 181 | 28, 703 | 796. 42 |  |  | 327, 926 | 241. 41 |  |  |
| Manganese ore, long tons | 172, 893 | 1, 764, 196 | 18, 436 | 320. 01 |  |  | 154, 144 | 178. 38 |  |  |
| Asphaltum, short tons | 127, 479 | 587, 477 | 51, 291 | 11, 552. 03 |  |  | 167, 097 | 3, 763. 45 |  |  |
| Pyrites, long tons | 388, 036 | 1, 469, 777 | 91, 705 | 4, 585. 25 |  |  | 197, 119 | 3, 942. 38 |  |  |
| Crude barytes, long tons | 191, 161 | 864, 313 |  |  | 839 | 4. 20 | 26, 313 | 32. 89 |  |  |
| Bromine, pounds | 3, 200, 588 | 918, 404 | 14, 201 | 3. 51 |  |  | 10, 915 | 9. 51 |  |  |
| Corundum, short tons (*o*) | 7, 873 | 926, 655 | 1, 201 | 115. 04 |  |  | 76, 285 | 260. 54 |  |  |
| Marls, short tons (*p*) | 7, 658, 265 | 3, 814, 956 |  |  | 843, 735 | 84. 37 |  |  | 436, 044 | 87. 21 |
| Precious stones |  | 851, 238 | } |  |  |  | 88, 807 | 88. 81 |  |  |
| Gold quartz, souvenirs, jewelry, etc |  | 760, 000 | } |  |  |  |  |  |  |  |
| Flint, long tons | 258, 113 | 1, 149, 137 |  |  | 8, 887 | 44. 44 |  |  | 30, 863 | 38. 58 |
| Fluorspar, short tons | 50, 500 | 232, 335 | 5, 500 | 137. 50 |  |  | 29, 835 | 186. 47 |  |  |
| Graphite, pounds | 2, 959, 408 | 358, 935 |  |  |  |  | 22, 862 | 45. 91 |  |  |
| Novaculite, pounds | 13, 762, 000 | 145, 560 | 5, 562, 000 | 1, 324. 29 |  |  | 24, 980 | 312. 25 |  |  |
| Feldspar, long tons | 119, 870 | 614, 194 |  |  | 5, 530 | 44. 24 |  |  | 20, 630 | 34. 38 |
| Chromic iron ore, long tons | 22, 988 | 362, 808 |  |  | 288 | 12. 59 | 2, 192 | 7. 88 |  |  |
| Mica, pounds | 842, 579 | 1, 774, 600 |  |  | 32, 169 | 39. 39 |  |  | 77, 825 | 60. 88 |
| Slate ground as pigment, long tons | 19, 475 | 207, 687 | 1, 000 | 100. 00 |  |  | 10, 000 | 100. 00 |  |  |
| Cobalt oxide, pounds (*q*) | 174, 789 | 256, 840 | 6, 704 | 92. 46 |  |  | 7, 092 | 29. 55 |  |  |
| Sulphur, short tons | 10, 665 | 302, 725 | 550 | 91. 67 |  |  |  |  | 13, 150 | 62. 62 |
| Rutile, pounds | 6, 150 | 19, 900 | 900 | 900. 00 |  |  | 2, 600 | 650. 00 |  |  |
| Asbestos, short tons | 4, 330 | 131, 612 |  |  | 120 | 80. 00 |  |  | 2, 512 | 58. 26 |
| Potters' clay, long tons | 592, 877 | 3, 036, 035 | 273, 561 | 1, 316. 27 |  |  | 435, 121 | 217. 06 |  |  |
| Grindstones |  | 4, 565, 787 |  |  |  |  |  |  | 60, 413 | 12. 08 |
| Millstones |  | 1, 306, 155 |  |  |  |  |  |  | 164, 845 | 82. 42 |
| Ozocerite, refined, pounds | 93, 500 | 5, 500 | 50, 000 |  |  |  | 2, 500 |  |  |  |
| Infusorial earth, short tons | 15, 999 | 130, 532 | 1, 633 | 89. 09 |  |  |  |  | 22, 288 | 48. 81 |
| Soapstone, short tons | 101, 156 | 1, 713, 373 | 4, 274 | 50. 63 |  |  | 165, 043 | 247. 57 |  |  |
| Fibrous talc | 111, 956 | 1, 223, 900 | 19, 536 | 464. 04 |  |  | 189, 440 | 346. 14 |  |  |
| Lithographic stone, short tons | 108 | 1, 943 | 18 |  |  |  | 243 |  |  |  |

---

*a* $1.2929 per troy ounce.

*b* $20.6718 per troy ounce.

*c* Including copper made from imported pyrites.

*d* Of 76.5 avoirdupois pounds net.

*e* Including nickel in copper-nickel alloy and in exported ore and matte, except for 1881, for which no returns are available for matte.

*f* Part of the antimony for 1889 was valued at Philadelphia.

*g* Except for 1880 and 1889 this includes brown coal and lignite and anthracite elsewhere than in Pennsylvania.

54 [illegible] and 1889 this includes all anthracite.

55 Lithographic stone, sho.

*a* Not including

*i* Of 42 gallons.

*j* Of 200 pounds.

*k* Of 300 pounds for natural cement and 400 pounds for artificial Portland.

*l* Of 280 pounds net.

*m* Except for 1889 this represents only the South Carolina product.

*n* Ocher and metallic paint.

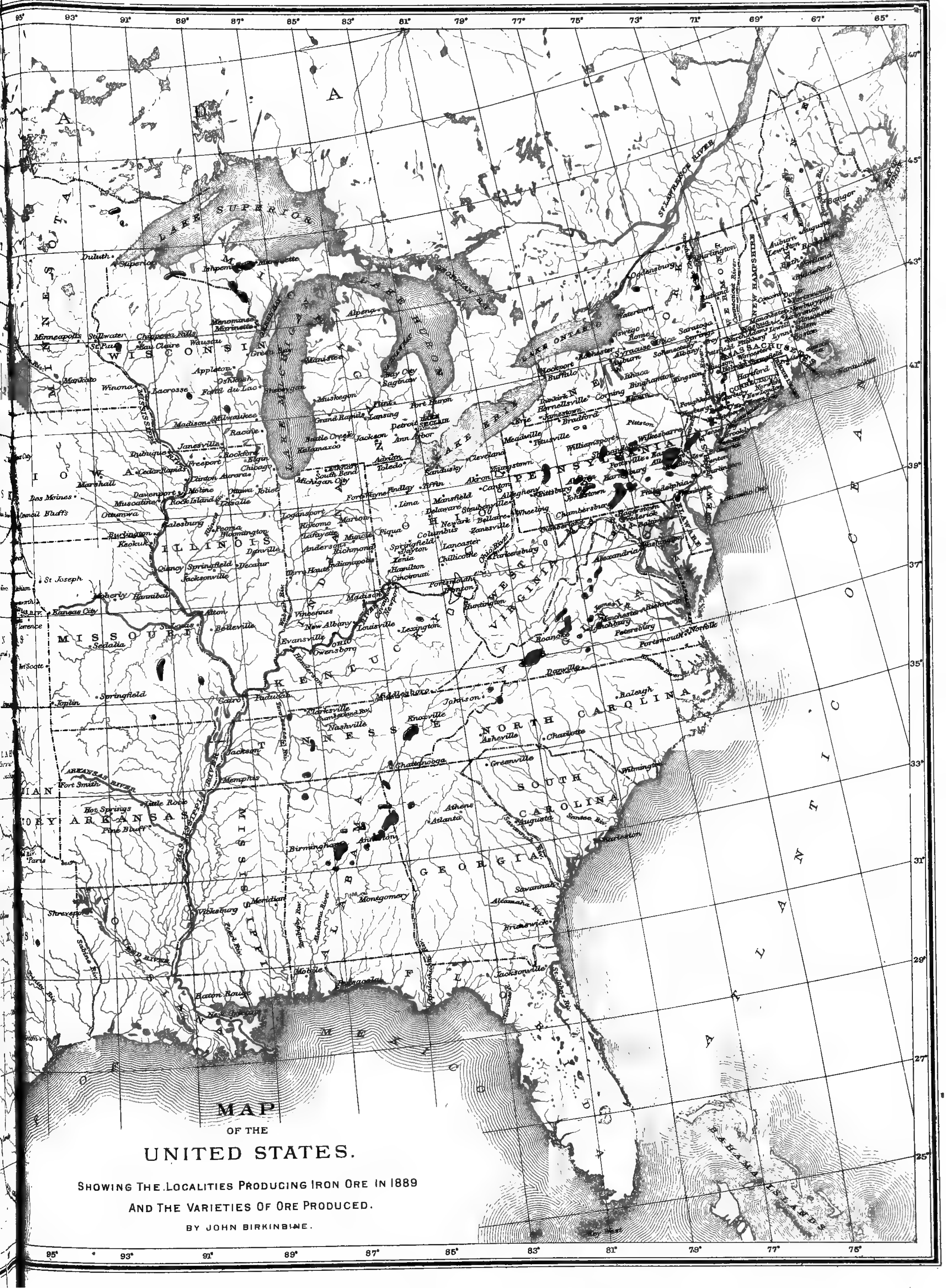
*o* Refined corundum from 1881 to 1888, both inclusive.

*p* Except for 1888 and 1889 this includes only New Jersey marls.

*q* Including cobalt oxide in exported ore and matte.

# IRON ORES.

Robert P. Porter, Superintendent.



# MAP

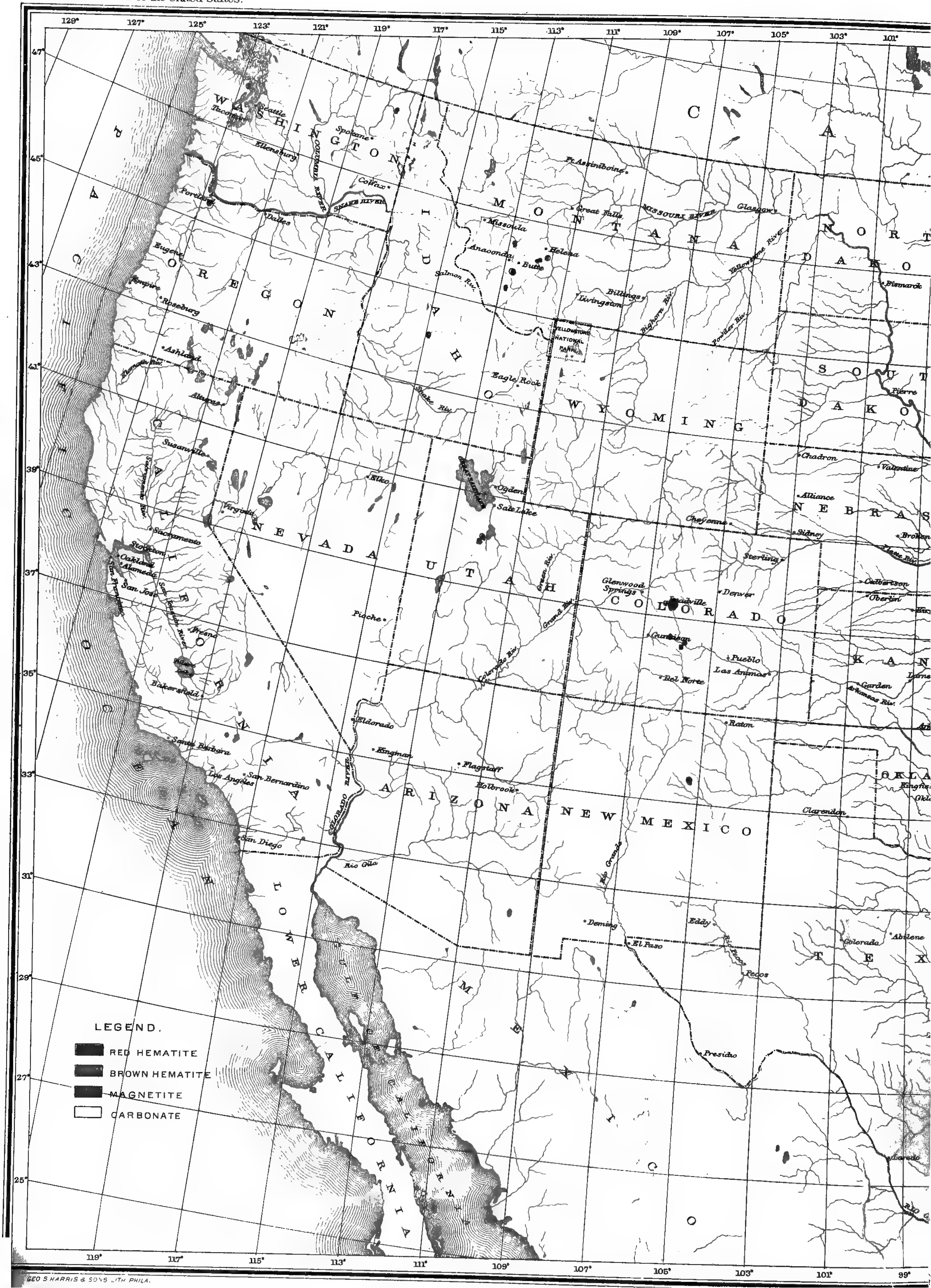
OF THE

# UNITED STATES.

SHOWING THE LOCALITIES PRODUCING IRON ORE IN 1889

AND THE VARIETIES OF ORE PRODUCED.

BY JOHN BIRKINBINE.



GEO S HARRIS & SONS LITH PHILA.

# IRON ORES.

BY JOHN BIRKINBINE.

## PRODUCTION.

During the year ended December 31, 1889, the production of iron ore amounted to 14,518,041 long tons, which was contributed by 26 states and 2 territories, and this output represented a value on cars or carts at the mines of $33,351,978, an average of $2.30 per long ton.

The stock of ore on hand at the commencement of the census year was 1,966,824 long tons, while at its close this amount was augmented to 2,256,973 tons, an increase for the entire country of 290,149 tons, or nearly 15 per cent The stock of iron ore carried over is equivalent to 15.55 per cent of the production for the census year, but the increased stock, representing the amount of ore mined during the year, but not consumed, is but 2 per cent of the total output for 1889. Owing to the fact that the census year for the mining industries corresponded with the calendar year 1889, the stocks of iron ore on hand at the commencement and end of the year represented a larger amount than would have been the case a few months earlier, the practice of mine managers whose products must reach a market by means of water transportation encouraging a depletion of stock at the mines during the shipping season and an augmentation during the winter months, when navigation is suspended.

The statistics of production are given by states, except where the names or operations of individuals would be disclosed. As the iron ore in several of the states is mined, respectively, by a single firm or corporation, the figures of these states are grouped with those of other states.

Some of the large mines reporting adopt a fiscal year, which, while not corresponding with the census year, offered more detailed information in regard to labor, wages, supplies, etc., than could be obtained for the calendar year 1889. Therefore, wherever the data furnished did not materially affect the figures of production the reports were accepted for a few mines for the fiscal year which corresponded closely with the census year.

The returns made to this office for the various states and territories were compared with the publications and reports of state officials wherever these were obtainable, and any discrepancies were carefully investigated.

Michigan was by far the largest producer of iron ore in the census year 1889, a total of 5,856,169 long tons having been mined, the value of which was $15,800,521 at the mines, an average of $2.70 per ton. The tonnage from Michigan therefore represents 40.34 per cent of the total, while the aggregate value is 47.38 per cent of that of the entire country.

The credit of holding second rank lies between the states of Alabama and Pennsylvania, the former, from the figures collected, having apparently a slightly greater output than the latter. This uncertainty is owing to the fact that the reports obtained from 2 of the larger Alabama mines covered operations commencing May 1, 1889, and ending May 1, 1890, and no detailed record of the amount of ore produced and labor employed during the 3 months of 1890 was obtainable. The position of Pennsylvania is also affected by the refusal of one large producer to supply absolute figures. Alabama is therefore placed second as a producer of iron ore, with 1,570,319 long tons, valued at $1,511,611, an average of 96 cents per ton. These figures represent 10.82 and 4.53 per cent, respectively, of the total output and value.

Pennsylvania closely follows Alabama, its output being 1,560,234 long tons, valued at $3,063,534, an average of $1.96 per ton, and 10.75 and 9.19 per cent, respectively, of the total output and value; but in the shipment or apparent consumption of iron ores Pennsylvania takes precedence of Alabama.

The other state which produced over 1,000,000 tons in the census year was New York, which is credited with 1,247,537 long tons, valued at $3,100,216, an average of $2.49 per ton, the figures representing, respectively, 8.59 and 9.30 per cent of the total output and value.

These 4 states therefore produced a total of 10,234,259 long tons, or 70.49 per cent of the entire output of the iron-ore mines of the United States, while the value of the ore aggregates $23,475,882, or 70.39 per cent of the total.

The following table shows the number of iron-ore mines reported and producing in 1889, the amount of iron ore produced, the average value per long ton, the total valuation of iron ore produced and consumed, the stock on hand at the commencement and end of the census year, and the apparent consumption or shipments of iron ore:

### PRODUCT AND VALUE OF IRON ORE IN 1889, BY STATES AND TERRITORIES.

[Long tons.]

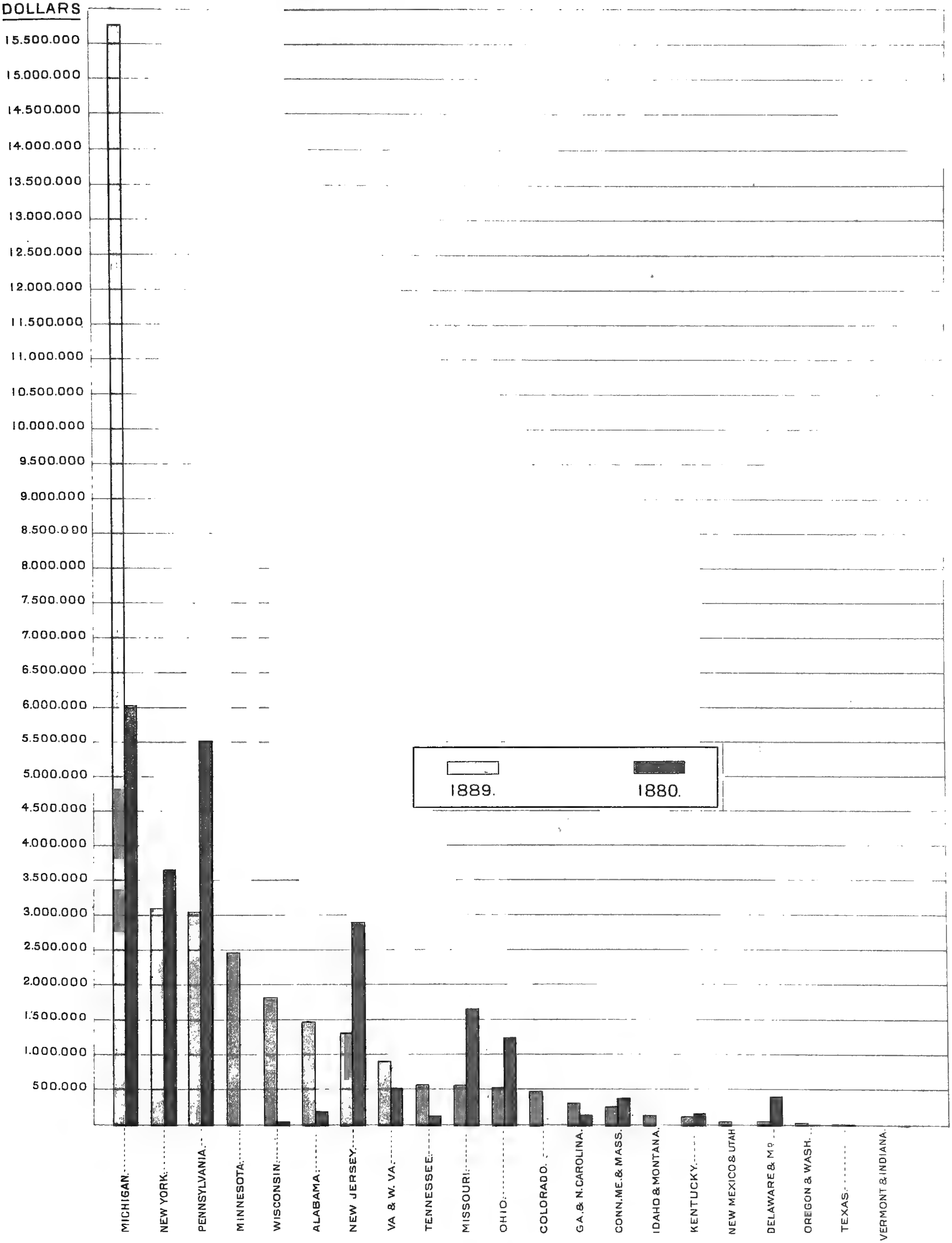
| STATES AND TERRITORIES. | Number of mines reporting. | Number of mines producing. | Amount produced. | Stock on hand January 1, 1889. | Stock on hand January 1, 1890. | Total value of production. | Value per ton. | Total shipments. | Total value of shipments. |
|---|---|---|---|---|---|---|---|---|---|
| Total | 685 | 592 | 14, 518, 041 | 1, 966, 824 | 2, 256, 973 | $33, 351, 978 | $2. 30 | 14, 227, 892 | $32, 766, 506 |
| Alabama | 48 | 45 | 1, 570, 319 | 61, 125 | 104, 462 | 1, 511, 611 | 0. 96 | 1, 526, 982 | 1, 457, 314 |
| Colorado | 19 | 18 | 109, 136 | 1, 628 | 7, 193 | 487, 433 | 4. 47 | 103, 571 | 469, 546 |
| Connecticut, Maine, and Massachusetts | 11 | 7 | 88, 251 | 22, 279 | 18, 723 | 265, 901 | 3. 01 | 91, 807 | 278, 888 |
| Delaware and Maryland | 16 | 14 | 29, 380 | 7, 298 | 14, 476 | 68, 240 | 2. 32 | 22, 202 | 54, 469 |
| Georgia and North Carolina | 20 | 17 | 258, 145 | 19, 443 | 32, 148 | 334, 025 | 1. 29 | 245, 440 | 317, 372 |
| Idaho and Montana | 9 | 7 | 24, 072 | 1, 893 | 4, 216 | 158, 974 | 6. 60 | 21, 749 | 140, 647 |
| Kentucky | 6 | 4 | 77, 487 | 17, 290 | 16, 491 | 135, 559 | 1. 75 | 78, 286 | 133, 885 |
| Michigan | 99 | 73 | 5, 856, 169 | 803, 700 | 903, 499 | 15, 800, 521 | 2. 70 | 5, 756, 370 | 15, 588, 369 |
| Minnesota | 4 | 4 | 864, 508 | 273, 395 | 278, 936 | 2, 478, 041 | 2. 87 | 858, 967 | 2, 464, 419 |
| Missouri | 8 | 8 | 265, 718 | 251, 091 | 291, 790 | 561, 041 | 2. 11 | 225, 019 | 470, 457 |
| New Jersey | 32 | 24 | 415, 510 | 98, 249 | 94, 890 | 1, 341, 543 | 3. 23 | 418, 869 | 1, 352, 509 |
| New Mexico and Utah | 3 | 2 | 36, 050 | 500 | 1, 000 | 70, 956 | 1. 97 | 35, 550 | 69, 956 |
| New York | 42 | 35 | 1, 247, 537 | 158, 223 | 185, 890 | 3, 100, 216 | 2. 49 | 1, 219, 870 | 3, 028, 676 |
| Ohio | 74 | 70 | 254, 294 | 58, 209 | 71, 083 | 532, 725 | 2. 09 | 241, 420 | 515, 148 |
| Oregon and Washington | 3 | 3 | 26, 283 | 3, 575 | 2, 740 | 39, 234 | 1. 49 | 27, 118 | 40, 389 |
| Pennsylvania | 198 | 189 | 1, 560, 234 | 82, 322 | 91, 989 | 3, 063, 534 | 1. 96 | 1, 550, 567 | 3, 045, 100 |
| Tennessee | 19 | 16 | 473, 294 | 29, 863 | 16, 844 | 606, 476 | 1. 28 | 486, 313 | 629, 454 |
| Texas | 3 | 2 | 13, 000 | 200 | 4, 300 | 19, 750 | 1. 52 | 8, 900 | 16, 554 |
| Virginia and West Virginia | 54 | 38 | 511, 255 | 53, 184 | 69, 634 | 935, 290 | 1. 83 | 494, 805 | 894, 951 |
| Wisconsin | 17 | 16 | 837, 399 | 23, 357 | 46, 669 | 1, 840, 908 | 2. 20 | 814, 087 | 1, 798, 403 |

The above statement is tabulated from actual returns, verified as far as possible, except by individual visitations to all of the iron-ore mines. The figures of production are probably below the actual results, for in some localities farmers gather ore at odd times and sell to blast furnaces in small lots, but wherever this amount could be obtained it is included in the table. No returns have been secured from a few mines; hence their outputs were omitted where they could not be closely estimated. Some persons who mine ore on a small scale keep such insufficient records that allowances had to be made from the figures reported. In other mines the practice of recording the output by the number of cars or skips handled has a tendency to underestimate the actual product.

Making allowance for all of the above, and possibly also for some scattered iron-ore mining of which the Census Office had no knowledge, the total amount of iron ore produced in the United States in the year 1889 probably exceeded 14,650,000 long tons. In the discussion of distribution, value, cost, etc., however, the actual figures as determined, viz, 14,518,041 long tons, will be used.

VALUE.—The value of iron ore given in the table represents averages only, for the locations of mines in relation to blast furnaces, etc., and the character of the ores won so influence their values that, except in a few instances, detailed information as to specific values can not be given without violating the promise to protect those who contributed information for the census. The amounts produced multiplied by the average value per ton gave the value of iron ore for each mine, and the products so obtained when added show the total value of the ore produced by the various mines. Dividing this total by the number of tons mined gave the average value per ton. The returns from the various mines were tabulated, and the difference between the stock on hand January 1, 1889, and January 1, 1890, was either added or subtracted, as the case might be, to or from the total amount of ore mined, giving the apparent shipments from each mine, which, multiplied by the average value per ton, gave the value of the shipments. These amounts added together gave the total shipments and the valuation of the same.

With the exception of a few mines in Wisconsin, the value of iron ore at the mines and the costs of mining in the states of Michigan, Minnesota, and Wisconsin may be taken as representing the iron-ore mining operations of mines in the Lake Superior region, which are wrought principally under ground, producing ores rich enough in iron to withstand heavy transport charges to distant points. On the other hand, the figures for Alabama, Tennessee, and Virginia and West Virginia represent the winning of leaner iron ores, which are chiefly consumed close to the mines. While much of this ore is obtained from underground workings, a considerable portion is won from open-cut operations. The value given for iron ores obtained from mines which may properly be considered in the Lake Superior region averaged $2.66 per ton, and the value of ores taken from mines in the states of Alabama, Tennessee, and Virginia and West Virginia averaged $1.20 per ton.



TOTAL VALUE OF THE IRON ORE PRODUCT OF EACH STATE IN 1889 AND 1880. SEE PAGES 14-16.

The highest average value per ton is reported in the returns from Idaho and Montana, where a limited amount of iron ore is won for fluxing ores of the precious metals. The lowest average value for any state is that of Alabama, where new but liberal underground exploitations of limited depths, or large open workings and facilities of mining, due to the character and the location of the ore deposits, contribute to place the value of iron ore at the mines at a low figure. Similar reasons also influenced to a greater or less extent the results in other states.

NUMBER OF MINES.—The number of persons, firms, or corporations reporting to this office as having iron-ore mines which may be considered as active is 685, of which 592 were producers in the census year 1889. Compared with the returns made in 1880, when the number of regular mining establishments was 805, besides a large number of irregular producers, aggregating, according to the compiled directory, 1,325, there has been a material decrease in the number of operators, which is accounted for by the fact that iron-ore mining as a business has assumed such proportions as to command greater capital and more intelligent management. Many producers mined but a few tons in 1880; but this class has in the 10 years which have elapsed become practically extinct except in a few localities. In the returns for the Eleventh Census there were but 81 mines reported which produced under 300 tons, while in the returns for the previous census 1,125 of the irregular producers furnished less than 300 tons.

All the mines reported in 1880 which were known or believed to have continued operations were supplied with schedules of the present census, and numerous new enterprises were sought out and data collected from them.

The growing demand for, and the appreciation of, the value of ores rich in iron have caused the abandonment or suspension of operations at numerous mines which produce ores carrying relatively small percentages of iron or high percentages of phosphorus, sulphur, etc. The development of the bessemer steel industry, which in the Tenth Census reported a production of 879,650 long tons of steel and in the Eleventh Census of 3,382,654 long tons, is also largely responsible for the exploration on a liberal scale of numerous mines from which ores were obtained specially valuable to this industry because they were low in phosphorus.

The number of operations reported is also affected by consolidation of adjoining properties, so as to work them under one management; and in a number of cases several mines which, though adjacent, are practically distinct workings are operated as a single plant, and hence separate reports of each mine were not required nor obtained.

Of the 65 mines mentioned, 31 produced between 50,000 and 100,000 tons, 17 between 100,000 and 200,000 tons, 11 between 200,000 and 300,000 tons, 2 between 300,000 and 400,000 tons, 2 between 500,000 and 600,000 tons, 1 produced 769,000 tons, and 1 produced 809,000 tons. Of these mines Michigan held the largest number, 29, 11 producing between 50,000 and 100,000 tons, 9 between 100,000 and 200,000 tons, 6 between 200,000 and 300,000 tons, 1 over 300,000 tons, 1 over 500,000 tons, and 1 over 800,000 tons. These figures give an indication of the development of large plants in the past decade, for deducting the 19 mines which each exceeded 50,000 tons output in 1880, and their aggregate production from the 805 regular and 1,325 irregular producers which contributed to make up the total of 7,120,362 long tons for the year 1880, there is a remainder of 786 regular and 1,325 irregular operations, producing a total of 4,923,179 tons or 2,332 tons per operation per annum. Similarly, deducting from the 592 mines which produced in 1889 14,518,041 long tons the 65 large operations and their aggregate output of 10,391,493 tons, the remainders show that 527 mines furnished 4,126,551 tons or 7,830 tons of iron ore per operation.

The apparent discrepancy between the number of producing mines and mines reported in the tables is accounted for by the fact that inquiries were directed to all known mines in process of practical development or temporarily idle but equipped with mining machinery and appliances, or which were inactive by reason of recent flooding or other exceptional causes. As all mining enterprises must first go through a course of development, and as a majority of mines are at times temporarily inactive from one cause or another, it seemed proper that as far as possible the labor employed in practical development work, with the cost of supplies for the same purpose, should be noted, and also that the figures tabulated should embrace as nearly as practicable the valuation of the plants and machinery at most of the mines which were temporarily inactive. The number of such operations which can not be included in the list of producing mines was not proportionately greater in the census year than during other years of the past decade, nor was the capital invested in equipment, machinery, and labor for development in excess of what is generally so employed.

The mines reported do not include any that were abandoned prior to December 31, 1888, or those concerning which it was impossible to obtain specific information. The actual number of reports received, viz, 685, was for producing mines or mines in position for immediate or future work, and these, as before indicated, in a number of cases represent several adjacent openings under a common management and operated as one mine. Mines which have for years been idle, numerous small openings which have been exploited to a greater or less extent, and scattered exploratory work in progress would considerably augment the number of apparent mining operations without increasing the quantity of iron ore won. These have not been considered, as it is impracticable to obtain full data of all such operations, and their figures of capital and labor would be misleading.

Placing the states in the order of the number of producing mines in 1889, the rank for the larger producers is as follows:

The number of productive mining operations (189) places Pennsylvania first, while the state ranks third in the amount of ore produced, viz, 1,560,234 tons.

Michigan, which had the largest output of iron ore for the year 1889, viz, 5,856,169 tons, had for this product but a comparatively small number of mines, viz, 73, many of which, however, were large operations.

Ohio follows next, with 70 producing mines, but as a producer of 254,294 tons it occupied eleventh position.

The fourth place is taken by Alabama, with 45 producing mines, while the state occupied second position as to the amount of ore won, 1,570,319 tons, the average output of the mines being large.

Virginia and West Virginia combined, with 38 mines, come next, and stand seventh as to the amount of ore won, viz, 511,255 tons.

New York ranks sixth in regard to the number of mines, viz, 35, many of which are large operations, and contributed to place the state in fourth place as a producer, with 1,247,537 tons.

New Jersey follows with 24 producing mines, while its 1889 output of 415,510 tons gave it ninth rank.

Minnesota reports but 4 active mines, and occupies a low rank in this respect. It, however, was fifth in the amount of ore produced, viz, 864,508 tons, indicating large mines.

Colorado produced but a small amount of ore (109,136 tons) during the year 1889, holding thirteenth position in this respect, and had 18 active iron-ore mines, showing but a small average from each.

Wisconsin, which held a high rank as a producer, with an output of 837,399 tons, had but 16 mines, most of which were large operations.

The following statement, exhibiting the average output per mining operation, is presented as illustrating one of the causes which influence the labor employed and the average cost of producing iron ore in each state:

AVERAGE PRODUCT PER IRON-ORE MINING OPERATION IN 1889.

| | LONG TONS. |
|---|---|
| The United States | 24,524 |
| Alabama | 34,896 |
| Colorado | 6,063 |
| Connecticut, Maine, and Massachusetts | 12,607 |
| Delaware and Maryland | 2,099 |
| Georgia and North Carolina | 15,185 |
| Idaho and Montana | 3,439 |
| Kentucky | 19,372 |
| Michigan | 80,221 |
| Minnesota | 216,127 |
| Missouri | 33,215 |
| New Jersey | 17,313 |
| New Mexico and Utah | 18,025 |
| New York | 35,644 |
| Ohio | 3,633 |
| Oregon and Washington | 8,761 |
| Pennsylvania | 8,255 |
| Tennessee | 29,581 |
| Texas | 6,500 |
| Virginia and West Virginia | 13,454 |
| Wisconsin | 52,337 |

In comparing this statement with that of the tons of ore won per employé, on page 18, it is noted that, with the exception of Tennessee, each of the seven states which show an output per mining operation above the average for the United States is among those which mined the largest quantity of ore per man in 1889.

In the preceding census year 19 mines were reported as producing over 50,000 long tons each, of which 10 furnished red hematite and 9 magnetite. These 19 mines contributed 2,197,183 long tons, or 30.86 per cent of the total amount of iron ore produced, in the year 1880 valued at $8,222,640, or 35.51 per cent of the total valuation. The largest production of any individual operation in that year was 250,000 tons. Another mine had an output of 200,000 tons, and 8 additional mines produced between 100,000 and 200,000 tons each in 1880.

In 1889 there were 65 mining operations, each of which reported a product exceeding 50,000 long tons. Of these, 46 furnished red hematite, 9 magnetite, 8 brown hematite, and 2 carbonate ores. These 65 mines aggregated a production of 10,391,490 long tons, representing 71.58 per cent of the total output of the country for the census year. The ore was valued at $24,340,611, or 72.98 per cent of the total valuation.

## CHARACTER OF IRON ORE MINED.

In classifying the iron ores produced in the year 1889, 4 general divisions were made, without particular reference to the geological occurrence of the ores, as follows: brown hematite, including limonite and bog ores; red hematite, including specular and fossil ores; magnetite ore; carbonate, including siderite, spathic, and blackband ores.

The formation and geological distribution of iron ores were considered at length by Professor Raphael Pumpelly in the reports of the Tenth Census (*a*), and the chemical and physical characteristics of each class and of many individual deposits were thoroughly discussed. In that census the ores were divided into 5 classes, viz, limonite, hematite, fossil, magnetite, and carbonate. The purpose of the present inquiry has been confined to the commercial features of the iron ore supply, and in order to simplify the classification for this report the hematite and fossil ores are combined under one head as red hematite. The gradations from one class of ore to another are so close that the divisions adopted can not be considered as perfect, but they approach within narrow limits the commercial classification generally accepted in the sale and purchase of American iron ores. The classification adopted may be defined as follows:

**BROWN HEMATITE.**—In this class are included all varieties of hydrated sesquioxide of iron, such as limonite, göthite, turgite, bog ores, pipe ores, etc. There are also included some manganiferous iron ores and most of the

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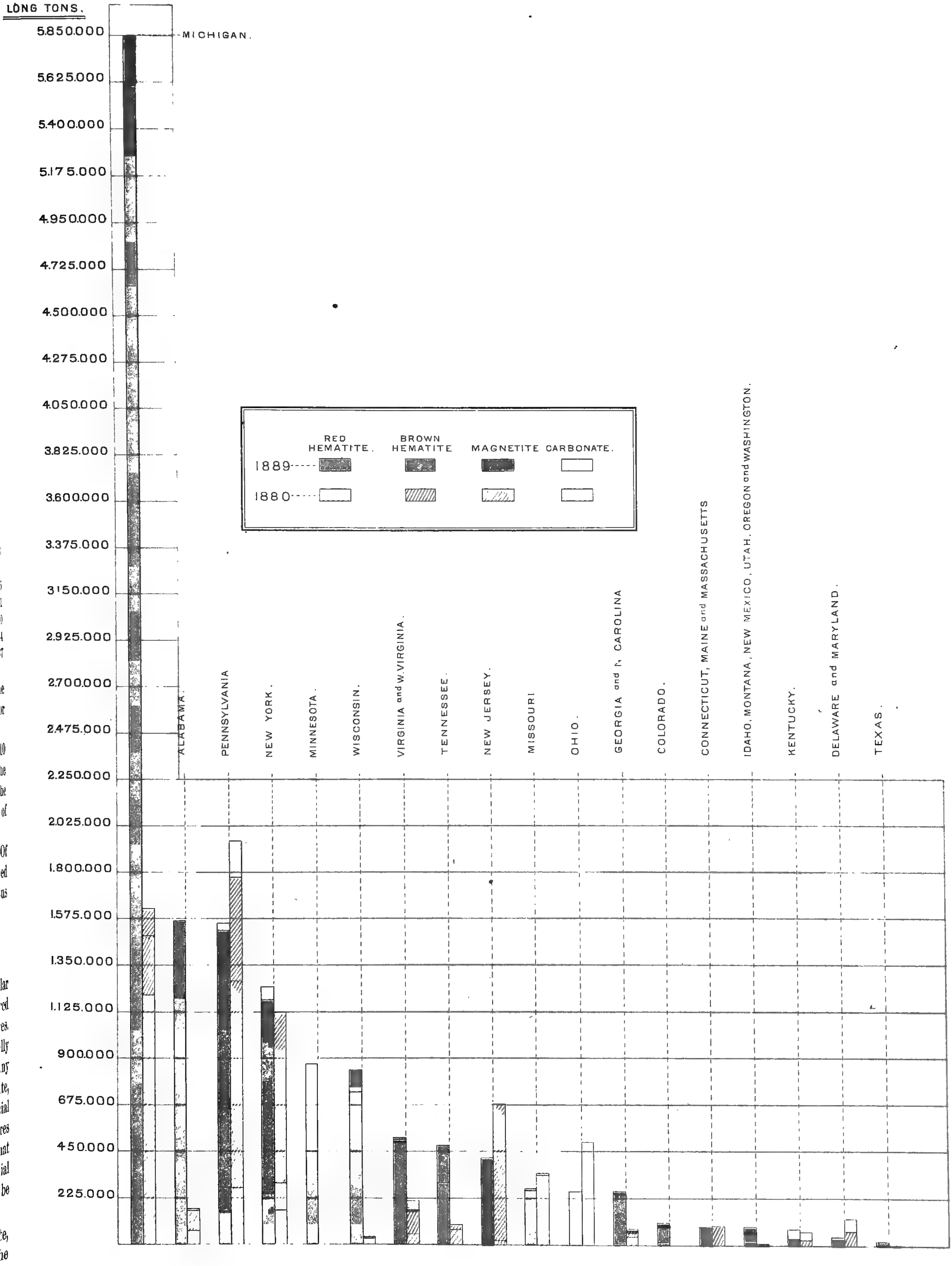
*a* See Tenth Census reports, volume xv, pages 3 to 22, inclusive.



IRON ORE BY KINDS IN EACH STATE IN 1889 AND 1880. SEE PAGES 6 AND 9.

ores mined in the Rocky mountain region specially for smelting argentiferous ores, but does not embrace the ores obtained from the coal measures, which are merely outcrops or portions of deposits of carbonate ores under light covering which have been weathered into limonite. The brown hematites are the most widely distributed of the classes, and are won chiefly from open workings, but the deposits are seldom localized in great masses.

**RED HEMATITE.**—This division embraces all practically anhydrous hematites recognized as red hematite. specular, micaceous, fossil, and slate iron ore, martite, blue hematite, etc. The terms "hard and soft hematite", "flaxseed ore", etc., used locally or in trade journals, are, like "blue hematite", merely expressions indicating physical characteristics. In the quantity of red hematite ore reported there are also included some hydrated ores, which, occurring in the same workings, are not separable. The same holds true, to a less extent, however, of those deposits in which red hematites occur closely associated with magnetite.

**MAGNETITE.**—Magnetite embraces all ores in which the magnetic oxide of iron ($Fe_3O_4$) is the predominant constituent, and the reports of this ore necessarily include some martite occurring in the same workings with magnetite.

**CARBONATE.**—Carbonate ore includes all ores in which protoxide of iron is found associated with a considerable percentage of carbonic acid, such as spathic ore, blackband, siderite, etc. In this class are embraced some carbonates which having been "weathered", are practically brown hematite as won from the earth. The term "kidney ore" and other similar appellations merely indicate physical characteristics.

The following table, exhibiting the amounts of each kind of ore mined in the different states, has been prepared upon the above classification, from which it is evident that 9,056,288 long tons, or 62.38 per cent of the iron ores produced in the United States in the census year, was of the red hematite variety; 2,523,087 long tons, or 17.38 per cent, was brown hematite; 2,506,415 long tons, or 17.26 per cent, was magnetite, and 432,251 long tons, or 2.98 per cent, was carbonate:

PRODUCTION OF VARIETIES OF IRON ORES.

[Long tons.]

| STATES AND TERRITORIES. | Brown hematite. | Per cent of total. | Red hematite. | Per cent of total. | Magnetite. | Per cent of total. | Carbonate. | Per cent of total. | Total production 1889. | Per cent of total. | Total production 1880. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 2, 523, 087 | 100. 00 | 9, 056, 288 | 100. 00 | 2, 506, 415 | 100. 00 | 432, 251 | 100. 00 | 14, 518, 041 | 100. 00 | 7, 120, 362 |
| Percentage of total output |  | 17. 38 |  | 62. 38 |  | 17. 26 |  | 2. 98 |  |  |  |
| Alabama | 379, 334 | 15. 03 | 1, 190, 985 | 13. 15 |  |  |  |  | 1, 570, 319 | 10. 82 | 171, 139 |
| Colorado | 100, 421 | 3. 98 | 4, 821 | 0. 05 | 3, 894 | 0. 15 |  |  | 109, 136 | 0. 75 |  |
| Connecticut, Maine, and Massachusetts | 88, 251 | 3. 50 |  |  |  |  |  |  | 88, 251 | 0. 61 | 92, 549 |
| Delaware and Maryland | 18, 061 | 0. 72 |  |  |  |  | 11, 319 | 2. 62 | 29, 380 | 0. 20 | 127, 102 |
| Georgia and North Carolina | 235, 057 | 9. 32 | 12, 963 | 0. 14 | 10, 125 | 0. 40 |  |  | 258, 145 | 1. 78 | 84, 584 |
| Idaho and Montana | 10, 479 | 0. 42 | 12, 089 | 0. 14 | 1, 504 | 0. 06 |  |  | 24, 072 | 0. 17 |  |
| Kentucky | 25, 212 | 1. 00 |  |  |  |  | 52, 275 | 12. 09 | 77, 487 | 0. 53 | 57, 865 |
| Michigan | 332, 257 | 13. 17 | 5, 272, 915 | 58. 22 | 250, 997 | 10. 01 |  |  | 5, 856, 169 | 40. 34 | 1, 640, 814 |
| Minnesota |  |  | 864, 508 | 9. 55 |  |  |  |  | 864, 508 | 5. 95 |  |
| Missouri | 400 | 0. 02 | 265, 318 | 2. 93 |  |  |  |  | 265, 718 | 1. 83 | 344, 819 |
| New Jersey |  |  |  |  | 415, 510 | 16. 58 |  |  | 415, 510 | 2. 86 | 676, 225 |
| New Mexico and Utah | 4, 033 | 0. 16 | 2, 017 | 0. 02 | 30, 000 | 1. 20 |  |  | 36, 050 | 0. 25 |  |
| New York | 30, 374 | 1. 20 | 224, 438 | 2. 48 | 927, 269 | 37. 00 | 65, 456 | 15. 14 | 1, 247, 537 | 8. 59 | 1, 126, 899 |
| Ohio |  |  |  |  |  |  | 254, 294 | 58. 83 | 254, 294 | 1. 75 | 488, 753 |
| Oregon and Washington | 26, 283 | 1. 04 |  |  |  |  |  |  | 26, 283 | 0. 18 | 6, 225 |
| Pennsylvania | 496, 555 | 19. 68 | 162, 957 | 1. 80 | 860, 916 | 34. 35 | 39, 806 | 9. 21 | 1, 560, 234 | 10. 75 | 1, 951, 496 |
| Tennessee | 174, 192 | 6. 90 | 299, 102 | 3. 30 |  |  |  |  | 473, 294 | 3. 26 | 93, 272 |
| Texas | 13, 000 | 0. 51 |  |  |  |  |  |  | 13, 000 | 0. 09 | 3, 214 |
| Virginia and West Virginia | 487, 208 | 19. 31 | 8, 746 | 0. 10 | 6, 200 | 0. 25 | 9, 101 | 2. 11 | 511, 255 | 3. 52 | 217, 448 |
| Wisconsin | 101, 970 | 4. 04 | 735, 429 | 8. 12 |  |  |  |  | 837, 399 | 5. 77 | 37, 000 |
| Indiana and Vermont |  |  |  |  |  |  |  |  |  |  | 958 |
| Output in 1880 | 1, 918, 622 |  | 2, 243, 993 |  | 2, 134, 276 |  | 823, 471 |  | 7, 120, 362 |  |  |
| Percentage of total output in 1880 |  | 26. 95 |  | 31. 52 |  | 29. 97 |  | 11. 56 |  |  |  |
| Amount of increase or decrease in 1889 | *a*604, 465 |  | *a*6, 812, 295 |  | *a*372, 139 |  | *b*391, 220 |  | *a*7, 397, 679 |  |  |
| Percentage of increase or decrease in 1889 |  | *a*31. 51 |  | *a*303.58 |  | *a*17. 44 |  | *b*47. 51 |  | *a*103.89 |  |

*a* Increase.

*b* Decrease.

Of the states, the largest producer of red hematite was Michigan, which is credited with 5,272,915 long tons, or 58.22 per cent of the total. In this class of ore Alabama comes next, with 1,190,985 long tons, or 13.15 per cent. Minnesota follows with 864,508 long tons, or 9.55 per cent; Wisconsin with 735,429 long tons, or 8.12 per cent, and Tennessee with 299,102 long tons, or 3.30 per cent. These 5 states contributed 8,362,939 long tons, or 92.34 per cent of the total output of red hematite mined in the census year 1889.

Nearly equal proportions of brown hematite and magnetite were produced, the former representing 2,523,087 long tons, or 17.38 per cent, and the latter 2,506,415 long tons, or 17.26 per cent, of the total iron ore output.

Pennsylvania contributed 496,555 long tons, or 19.68 per cent; Virginia and West Virginia together, 487,208 long tons, or 19.31 per cent; Alabama, 379,334 long tons, or 15.03 per cent, and Michigan 332,257 long tons, or 13.17 per cent, of the brown hematite mined in 1889. These 5 states therefore are credited with 1,695,354 long tons, or 67.19 per cent of the total output of brown hematite ore.

New York is the largest producer of magnetite, with an output of 927,269 long tons, or 37 per cent of the total of that class of ore mined, Pennsylvania coming next, with 860,916 long tons, or 34.35 per cent, followed by New Jersey, with 415,510 long tons, or 16.58 per cent, and Michigan, with 250,997 long tons, or 10.01 per cent. These 4 states produced 2,454,692 long tons, or 97.94 per cent of all the magnetic iron ore mined in 1889.

The carbonate iron ores mined in 1889 amounted to but 432,251 long tons, or 2.98 per cent of the total output, of which Ohio contributed 254,294 long tons, or 58.83 per cent; New York, 65,456 long tons, or 15.14 per cent; Kentucky, 52,275 long tons, or 12.09 per cent, and Pennsylvania, 39,806 long tons, or 9.21 per cent. These 4 states produced 411,831 long tons, or 95.28 per cent of the total of this kind of ore mined.

New York and Pennsylvania are the only states reported as producing the 4 kinds of ore. Colorado, Michigan, and Virginia each produced 3 kinds of ore.

Comparing the relative rank of the states as producers of the various characters of ore with their positions a decade before, it is found that of red hematite producers Michigan, with a largely increased output, still heads the list. Alabama has risen from sixth place in 1880 to second place in 1889. Pennsylvania and New York, which occupied third and fourth places, respectively, in the Tenth Census, have fallen to eighth and seventh places, respectively, while Minnesota, which did not produce ore in 1880, has taken third place and Wisconsin fourth place in 1889 as producers of red hematite iron ore.

In the brown hematite class Pennsylvania still occupies first place. Virginia and West Virginia combined have risen from fourth place in 1880 to second in 1889; Alabama, which was fifth in 1880, takes third place, and Michigan has fallen from second to fourth place.

The relative rank of the first 4 states producing magnetite in the year 1889 remains the same, with the exception that Pennsylvania and New Jersey have changed places, the former now taking precedence of the latter, New York heading and Michigan closing the list.

Ohio still contributes more than one-half of the output of carbonate ores, outranking other states in this particular, followed by New York, which is reported as not producing any carbonate ores in 1880. Kentucky and Pennsylvania, which held, respectively, fifth and second places in 1880, take third and fourth places in 1889.

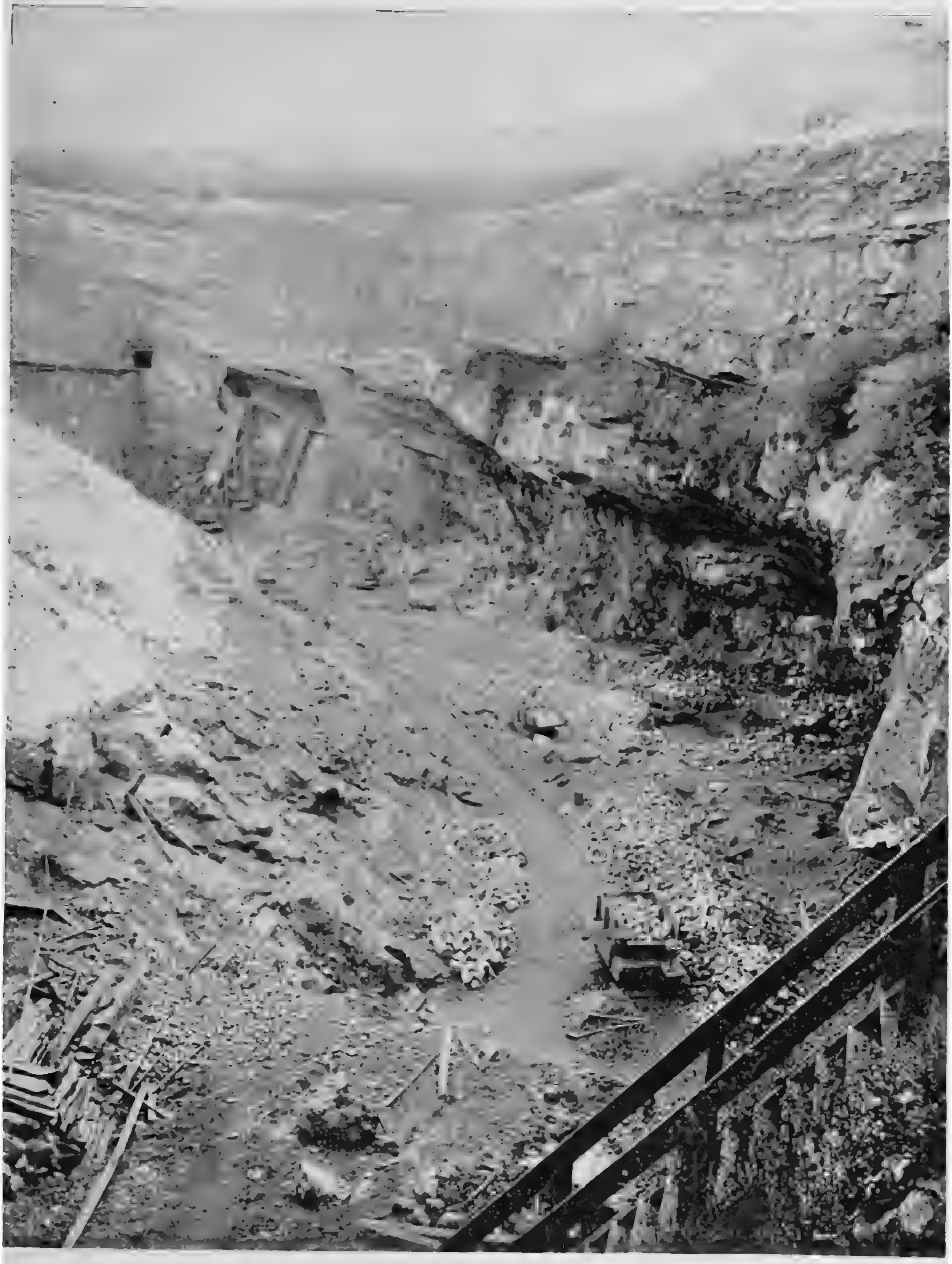
While the total amount of iron ore produced in 1889, 14,518,041 long tons, is more than double (an increase of 103.89 per cent) that given in the census of 1880, viz, 7,120,362 long tons, the increase has been most marked in the amount of red hematite, the product of which in 1889 was 9,056,288 long tons, or over four times that of 1880, when the output amounted to 2,243,993 long tons. The amount of magnetite increased from 2,134,276 long tons in 1880 to 2,506,415 long tons in 1889 (17.44 per cent), and the brown hematite class was augmented in production nearly one-third (31.51 per cent), from 1,918,622 long tons in 1880 to 2,523,087 long tons in 1889. The production of carbonate ore, however, showed a decline of about one-half (47.51 per cent) from the production of the Tenth Census, viz, 823,471 long tons, to 432,251 long tons.

The production of the various kinds of ore mined at the Tenth and Eleventh Censuses shows that in relation to the total amount of iron ore won the red hematite produced in 1889 was 62.38 per cent, or nearly double the proportion reported in 1880, viz, 31.52 per cent. The proportion of magnetite decreased from 29.97 per cent in 1880 to 17.26 per cent in 1889; the brown hematite similarly fell from 26.95 per cent in 1880 to 17.38 per cent in 1889, and the carbonate from 11.56 per cent in 1880 to 2.98 per cent of the total in 1889.

The division by states does not fairly represent the importance of the iron-mining industry locally. Taking the figures from the preceding table, they show that the red hematite ore produced in Michigan, Minnesota, and Wisconsin, amounting together to 6,872,852 long tons, represents 75.89 per cent of the total amount of the output, all of which, with the exception of a small amount obtained from the fossil ore deposits of eastern Wisconsin, was taken from the portions of the 3 states named, which are recognized as the Lake Superior region.

Similarly, the production of this class of ore in Alabama, Georgia, and Tennessee should be grouped, giving a total of 1,503,050 long tons, or 16.6 per cent of the total red hematite ore production. The output of this class of ore in New York is divided between the red hematites of the northern portion and the fossil ores of the central portion of the state; that of Missouri is divided between the specular ores of the Iron Mountain and Pilot Knob district and the softer ores of central Missouri.

The brown hematite or limonite ores credited to Michigan and most of those reported from Wisconsin are found with the red hematite in the Lake Superior region. A portion of the brown hematite, however, is obtained from the southern and western central portions of the latter state. It is proper to group the brown hematites of Alabama and Georgia, and also most of those credited to Tennessee, as one district. Taking the total of the 3 states named, their output aggregates 788,583 long tons, or 31.25 per cent of the total brown hematite production.



RED HEMATITE MINING AT IRON MOUNTAIN, MISSOURI. (See page 23.)

Of the magnetite ore of New York the major portion came from the Lake Champlain district, the balance being from the vicinity of the lower Hudson river. Most of the magnetite from Pennsylvania is obtained from the Cornwall ore hills, the balance being distributed among numerous mines along the South mountain, while the New Jersey magnetites come chiefly from the mines grouped in the center of the state. Michigan's contribution of magnetic ore was obtained from a limited area in the Marquette range of the Lake Superior region.

The limonite of Pennsylvania covers a considerable area, and embraces several districts, a broad belt carrying this ore passing through the state into Maryland, Virginia, Tennessee, Alabama, and Georgia.

The entire product of Ohio consists of carbonate ores, which are produced chiefly in 2 contiguous districts in the central and southern portions of the state. The carbonate ores obtained from Kentucky are from a district separated from a similar producing territory in southern Ohio by the Ohio river, the portions of the 2 states being generally grouped under the name of the Hanging Rock region. At the outcrops or under light covering many carbonate ores are weathered into limonite, but no attempt has been made to subdivide the weathered from the unweathered ores. The carbonate ores of New York are found near the Hudson river, 110 miles from its mouth, and those in Pennsylvania are mostly in the western section of the state.

In discussing the character of the ores mined, attention is called to the fact that most of the ores imported from foreign countries are hematites, the red hematites predominating. No actual subdivision, however, is authentically published.

## GEOGRAPHICAL DISTRIBUTION OF IRON-ORE MINES.

Although the iron ores of the United States are liberally distributed, the production in the year 1889 came from comparatively limited areas, as illustrated by the outputs of various portions of the country and by the accompanying map.

If the United States be divided into eastern and western sections by the most prominent physical feature, namely, the Mississippi river and the headwaters of this stream are connected by an imaginary line with the Lake of the Woods, the figures show that the output in 1889 of the portion of the United States east of this division was 14,043,782 long tons, or 96.73 per cent of the total production of the United States, and that of the western division 474,259 long tons, or 3.27 per cent. If the eastern division is again subdivided by a line nearly east and west, following the Ohio and Potomac rivers, uniting these along the southern boundary of Pennsylvania, the product of the northern portion was 11,153,282 long tons in 1889, or 79.42 per cent of the output of the eastern division and 76.82 per cent of the total for the United States, and the southern portion 2,890,500 long tons, or 20.58 per cent of the product of the eastern division and 19.91 per cent of the total for the United States.

While the above sections include practically state divisions as far as output is concerned, and show groupings of iron-ore producers in but limited portions of the territory, they would, if subdivided into districts, demonstrate how small were the areas actually contributing to the supply of iron ore. To illustrate this, a few of the prominent producing centers may be instanced. The 4 districts or ranges embraced in the Lake Superior region are none of them of great extent geographically, and if a circle was struck from a center in Lake Superior with a radius of 135 miles, all of the present iron-ore producing territory of that region would be embraced within one-half of the circle, and most of the deposits would be near the periphery. The output of this section in 1889 was 7,519,614 long tons. A parallelogram 60 miles in length and 20 miles in width would embrace all of the mines now producing in the Lake Champlain district of northern New York, whose output in 1889 aggregated 779,850 long tons. A circle of 50 miles radius, embracing portions of eastern Alabama and western Georgia, included mines which in 1889 produced 1,545,066 long tons. A single locality, Cornwall, in Lebanon county, Pennsylvania, contributed 769,020 long tons in 1889.

There are other important centers of iron-ore production, and large amounts are obtained locally at various points, but the above sufficiently demonstrates that in the areas named, which are only occupied to a limited extent by iron-ore mines, there were produced in 1889 a total of 10,613,550 long tons, or 73.11 per cent of the entire output of iron ore for the United States.

## CONSUMPTION.

Adding to the stock of iron ore on hand January 1, 1889, 1,966,824 long tons, the production for the year, 14,518,041 tons, and deducting the stock on hand January 1, 1890, 2,256,973 long tons, there is an apparent total consumption of 14,227,892 tons, valued at $32,766,506. To this apparent consumption, however, should be added (1) the materials which are charged into blast furnaces as ore, but which are products coming from the puddling and heating furnaces and the rolls and hammers of rolling mills; (2) the charges drawn from the retorts in which the franklinite of New Jersey is treated for the removal of zinc, leaving as a residuum a mixture of iron and manganese oxides, employed in blast furnaces for producing spiegeleisen, and (3) the blue billy or purple ore, the residuum of pyrites burned to produce sulphuric acid, and some of the silicates of iron, which, as slag, result from the treatment of copper ores, may also be utilized and smelted as iron ores.

The approximate amounts of these materials consumed (most of which were fed to blast furnaces) in 1889 are as follows (the figures being partly from estimates and partly from data specially collected for this report):

APPARENT CONSUMPTION OF IRON ORE.

| | LONG TONS. |
|---|---|
| Domestic iron ore | 14,227,892 |
| Rolling-mill cinder, roll and hammer scale, residuum from treating zinc ores, blue billy, and slags | 652,000 |
| Imported iron ore, mostly for producing pig iron | 853,573 |
| Total consumption of iron ore or other material used as iron ore in the United States | 15,733,465 |

This consumption can not be distributed with accuracy, for the census inquiries did not include following the ore to the consumers; but approximate figures obtained from other sources permit of giving a general idea as to the extent to which iron ore is used for special purposes.

The rolling mills of the country consumed in the year 1889 for "fix" or "fettling" about 375,000 long tons of iron ore, mostly from domestic mines. The silver smelters used for flux, as reported by operators of mines to this office, 157,908 long tons of iron ore. This does not include any ores which were high enough in silver to encourage their use independent of their iron contents. In the open-hearth steel furnaces, and in making blooms direct from ore in forges or by other direct processes, the consumption approximated 49,500 long tons. This leaves for the consumption of blast furnaces in the United States, say, 15,151,057 long tons of iron ore, mill cinder, etc.

Making allowances for mill cinder, roll and hammer scale, etc., used, there is a total consumption of iron ore of, say, 14,499,057 long tons in the blast furnaces in the United States, or, if the foreign ores (of which 7,500 tons are estimated as used in rolling mills, forges, etc.) are omitted from the calculation, the consumption in American blast furnaces of iron ore produced from domestic mines was 13,652,984 long tons.

Allowing for discrepancies in the figures presented as mentioned under the head of "Production", there were supplied to American blast furnaces in the year 1889 fully 13,780,000 long tons of domestic ore.

The following résumé illustrates the apparent consumption of iron ore and materials used as iron ore in the year 1889:

APPROXIMATE CONSUMPTION OF IRON ORE, ETC., BY VARIOUS INDUSTRIES IN 1889.

[Long tons.]

| ITEMS. | Total. | Used in rolling mills, forges, etc. | Used in silver smelting. | Used in blast furnaces. |
|---|---|---|---|---|
| Total | 15,733,465 | 424,500 | 157,908 | 15,151,057 |
| Domestic iron ore | 14,227,892 | 417,000 | 157,908 | 13,652,984 |
| Foreign iron ore | 853,573 | 7,500 | .............. | 846,073 |
| Mill cinder, scale, residuum, blue billy, etc | 652,000 | .............. | .............. | 652,000 |

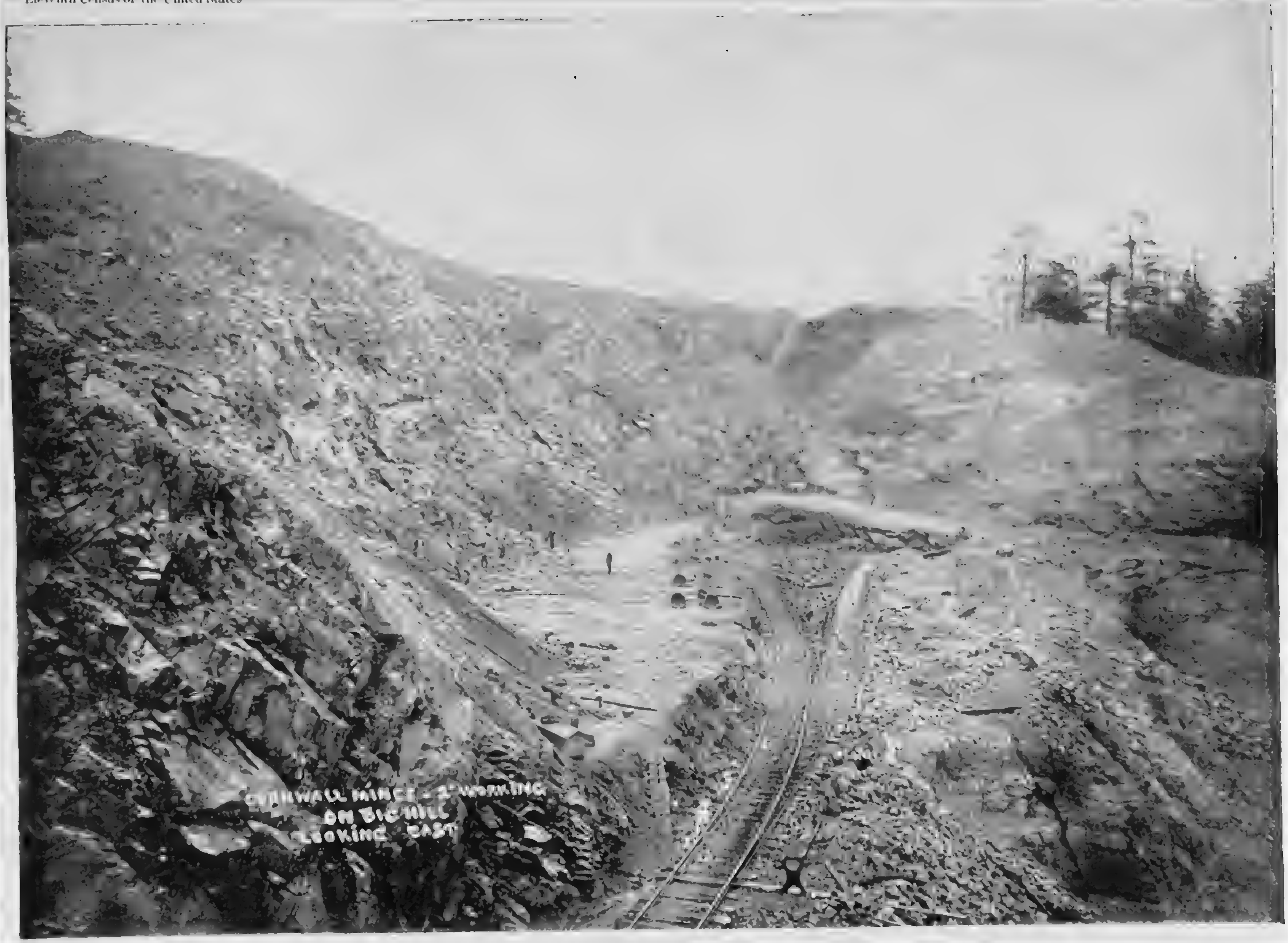
## YIELD OF METAL FROM IRON ORES USED.

From the apparent consumption, of 13,652,984 long tons of domestic iron ore in blast furnaces it is possible to estimate the average yield of American iron ore fed to these furnaces. As near as can be estimated, the average yield in blast furnaces of foreign iron ore, domestic mill cinder, residuum, blue billy, etc., was 57 per cent, producing 853,902 long tons of pig iron.

Dr. William M. Sweet, special agent, announced the total production of pig iron for the census year ended June 30, 1890, as 9,579,779 short tons, equivalent to 8,553,374 long tons, and Mr. James M. Swank, general manager of the American Iron and Steel Association, reported the production for the calendar year 1889 to be 8,516,079 short tons, or 7,603,642 long tons. The difference of nearly 1,000,000 tons between these two statements is due to the two periods covered by the tables of statistics; that of Mr. Swank, however, being for the same period as the inquiry into the production of iron ore under direction of the Census Office, would seem to be the fairer basis for calculation. A considerable portion of iron ore mined in the Lake Superior district and in northern New York is accumulated at docks and at blast furnaces toward the close of the calendar year and held there on account of the suspension of navigation during the winter months. It would seem equitable, therefore, in determining the percentages of iron in the ores used, to base the calculation upon an amount of pig iron somewhat greater than that reported by Mr. Swank, and yet not so much as that given by Special Agent Sweet, for the reason that the first half of the year 1890 showed a much larger output than the first six months of 1889.

Taking 853,902 long tons as the amount of pig iron obtained from foreign ore, mill cinder, etc., from 7,603,642 long tons, as reported by Mr. Swank, there is a balance of 6,749,740 long tons, to produce which 13,652,984 long tons of domestic iron ore were used. If, however, for the reason above mentioned, a total production of 7,000,000 long tons of pig iron is allowed from a total of 13,652,984 tons of iron ore, the average yield would be 51.27 per cent.

In the Tenth Census the average yield of iron ore was determined by analyzing samples collected and multiplying the product in tons by the approximate percentage of iron so found. The result was an apparent average



MAGNETIC IRON-ORE MINING AT CORNWALL, PENNSYLVANIA.

(See page 22.)

yield of 51.22 per cent. This would indicate that slightly richer mixtures were used in 1889 than in 1880, but had the estimates for the Tenth Census been made upon the same basis as those above given for the Eleventh Census the difference would be more apparent. The tendency to use richer ores has fostered the liberal development of mines in the Lake Superior region, encouraged an enrichment of ores by sorting, separating, and concentration, and also affected the importation of foreign iron ore. The result has been the abandonment of many mines producing ores carrying low percentages of iron which were active in the year 1880. The large increase in blast furnace capacity and necessarily augmented demand for iron ores in some of the southern states, where comparatively lean ores abound, has not, however, been sufficient to keep the average yield of iron ore below what it was in 1880.

In order to check up the totals of the different kinds of iron ore reported and obtain approximately their actual yield in blast furnaces, letters were mailed to the furnace managers, inclosing schedules which they were requested to fill out. On these schedules the amounts of the different classes of ore, viz, red hematite, brown hematite, magnetite, carbonate, and the general localities from which they were obtained, as well as the amount of foreign ores, mill cinder, etc., used and the pig iron produced in 1889, were given. Full returns were obtained from most of the states, and in instances where parties failed to supply the desired information it was possible to estimate closely from other data accessible the amounts of iron ore used and pig iron made.

From these reports and supplementary information the following statement was prepared concerning the pig iron producing value of the iron ores used in or obtained from the various states.

The returns received from Alabama blast furnaces represent 90 per cent of its output, and show that a great majority of the ores used were obtained from local mines, although some ore was brought in from Georgia and Tennessee. The average yield in the blast furnaces of the iron ores used was 44.4 per cent. Over 70 per cent of these ores was red hematite, the balance being brown hematite, with the exception of 2,100 long tons of mill cinder, etc. The blast furnace reports show that the ores used ranged from 30.5 to 51.6 per cent of iron.

The ores used in Colorado are all local, and show an average yield of 55 per cent of iron.

The New England states which supplied iron ores, Maine, Connecticut, and Massachusetts, used local ores entirely, and full reports have been received from that section showing an average of 44 per cent of iron in the brown hematites smelted, this being the only character of ore at present mined in these states.

Most of the ores used in Georgia and North Carolina blast furnaces are local, in approximate proportions of 0.3 brown hematite, 0.5 red hematite, and 0.2 magnetite and mill cinder, the average yield being 40.7 per cent of iron.

Illinois produced no iron ores and obtained the supply for its furnaces from the Lake Superior region, the returns showing a yield of 60 per cent, which is practically a fair indication of the character of iron ore shipped to points of consumption distant from the Lake Superior region. 94 per cent of the ore charged to the Illinois furnaces was red hematite, 2.5 per cent magnetite, and 3.5 per cent mill cinder, etc.

Kentucky blast furnaces depended upon local ores, chiefly roasted carbonates and brown hematites. These ores gave a yield of 46.2 per cent in the blast furnaces of the state.

The yield in Maryland blast furnaces using chiefly local and Virginia ores averaged 41 per cent, but others consuming ores imported from Cuba and Mediterranean ports bring the average for the state up to 47.7 per cent.

The location of the majority of the Michigan blast furnaces within convenient distances of the ore supply gave these plants, which use charcoal as fuel, some ores of lower grade than could stand transportation to distant points, and hence the yield of ore in these furnaces, viz, 58 per cent of iron, is lower than that of Lake Superior ores in furnaces at greater distances. Red hematites formed the bulk of the supply, but some magnetites and brown hematites were also used.

The Missouri blast furnaces used local ores, yielding 56.4 per cent of iron, principally red hematite, with a small admixture of brown hematite.

The blast furnaces in New Jersey, while depending chiefly upon the local magnetites, receive portions of their supply from the Lake Superior region, from New York, a small amount from Pennsylvania, and also some foreign ores, the yield for the state being 50.9 per cent.

About one-half of the ores used in New York were local magnetites; over 30 per cent were red hematite from that state and the Lake Superior region, the balance being brown hematite from New York and the New England states, carbonates from New York, foreign ores, mill cinder, etc. The average yield was 52.7 per cent of iron.

Ohio obtains the bulk of its ores from the Lake Superior region and from its local carbonate deposits, although some magnetite from New York, carbonate ores from Kentucky, and red hematite from Missouri are smelted. These ores yielded, on an average, 56.7 per cent of iron.

Oregon supplies the brown hematite ore used in its blast furnace, which yielded about 32 per cent of iron.

Pennsylvania was the largest consumer of foreign ores in 1889, fully 85 per cent of the reported total of this class of ore being shipped into that state, and several furnaces obtained their entire supply from this source, with occasional admixture of local mill cinder. It is also the heaviest consumer of Lake Superior ores, drawing most of its red hematite from that region, supplemented by some of the local ores. In addition to its liberal supply of magnetite from the Cornwall ore hills, Dillsburg, etc., it obtains this class of ore from New York, New Jersey, and the Lake Superior region. The brown hematites are mostly obtained from local mines, although some were brought from Virginia. Local carbonates and some from New York and Ohio are also used. Instances of dependence upon one class of ore show a yield from hematites obtained from Spain, Greece, and Africa of 63.6 and 60.2 per cent; of all Lake Superior ores, 61.5, 61.8, 62.6, 60.8, 60, and 59.5 per cent; of all Pennsylvania magnetites, 51, 50.9, 49.1, 48.9, and 48.5 per cent; of Pennsylvania brown hematite, 45.6 and 41.2 per cent; of local fossil ores, 36.9 per cent, and of hematite ore from Cuba and Mediterranean ports, 56.6 per cent. The average for the state is 55.3 per cent.

The brown and red hematites which are the base of supply for Tennessee furnaces come from local mines, with additions from Alabama and Georgia. Some carbonate ore and mill cinder are also used, the yield for the state being 41.6 per cent. Furnaces using brown hematites only show an average iron contents of 38.8 per cent.

The Texas brown hematites (bog ores), the only character of ore used in that state, yielded 45.8 per cent of iron when roasted.

Virginia depends principally upon her brown hematite mines, which supplied about 90 per cent of the ore used in that state, the balance coming from local red hematite mines, magnetites mined in North Carolina, and a small amount of mill cinder. These gave an average yield of 43.4 per cent of iron. Several furnaces depend entirely upon the brown hematites, which showed percentages of 48.6, 43.3, and 41.4 of iron, respectively.

Local brown hematite (bog ores) and magnetite from British Columbia were used in the Washington blast furnace, the latter yielding 64 per cent of iron when roasted.

West Virginia obtains all of the ore for its furnaces from the Lake Superior district and Missouri, with the exception of some local brown hematite and carbonate ores, a small amount of magnetite, and mill cinder. This raises the average close to 60 per cent of iron.

Wisconsin's blast furnaces also draw their supply from the Lake Superior district, and with the exception of some mill cinder, local red and brown hematites, these were the only ores used, the average yield for the state being 57.2 per cent of iron.

The above averages are presented as indicating the general character of iron ores used in the localities mentioned during the year 1889, but constant changes in mixtures of ores and the introduction of supplies from sources heretofore untried may materially change the figures given. The furnaces which depend upon and have in reserve large quantities of local ores, or those built to rely upon certain ores brought to them over long distances, will probably show the least change.

## BENEFICIATING AND CONCENTRATING IRON ORE.

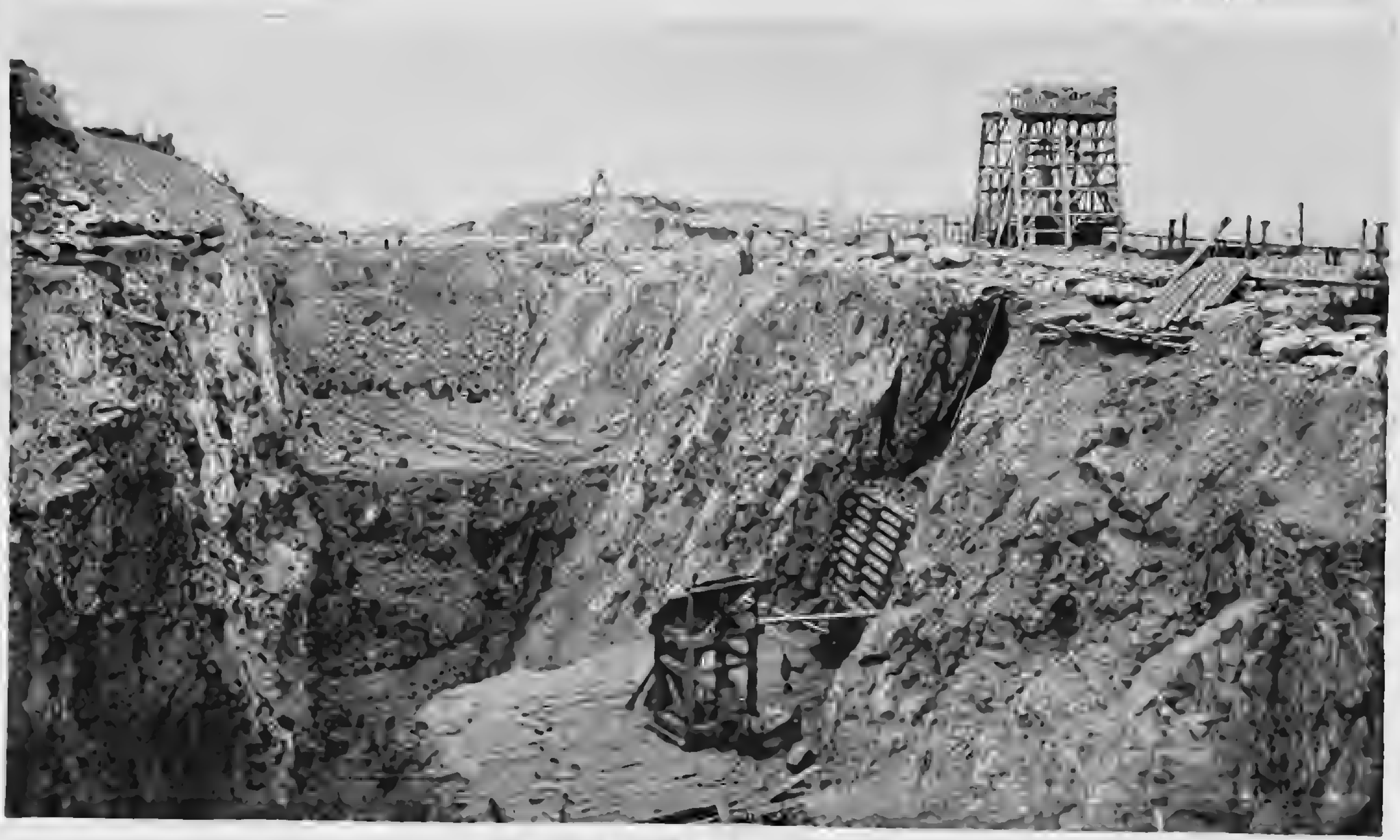
The figures given in this report are for the ores as shipped to consumers, and therefore the actual amount mined aggregates considerably greater than the tonnage named, because in a number of instances the ores are treated at the mines to enrich them. Thus most of the carbonate ores which are produced are roasted at or close to the mines to drive off the carbonic acid. Some of the sulphurous ores are similarly treated, but as a rule those which carry sufficient sulphur to require roasting are delivered to blast furnaces or other consumers as mined, and the roasting is done at the point of consumption. Limited amounts of brown hematites are also roasted to facilitate crushing lumps, or to drive off an excess of water. Most of the mines which produce brown hematite are equipped with washing appliances for removing the clay, sand, etc., from the ores, so that the material is shipped to the furnaces comparatively free from these objectionable features, which decrease the value of the ore. Jigs are employed to a limited extent to cleanse some of the red hematites and magnetites, and in Missouri lean specular ores or old dumps are hydraulicked before the material is jigged.

The year 1889 marked a revival in magnetic concentration, whereby ores carrying smaller percentages of iron than would pay for their exploitation and shipment, or iron ores which have an excess of phosphorus, as apatite, or of sulphur in the shape of pyrites, are granulated and passed over various forms of apparatuses, in which are currents of electricity or fixed magnets to attract the magnetic material, allowing the nonmagnetic to pass away as tailings. This revival in 1889 was confined largely to the construction and equipment of plants for treating ores on a liberal scale or experiments with various machines under different conditions. As a result of this the amount of such ore produced was small, but subsequently the completion of plants, aggregating a cost of over $500,000, their operation and the results of experiments made this feature an important one, and one which will probably grow with each year. The amount of iron ore which was prepared and passed through water jigs or magnetic separators in 1889 amounted to 95,425 long tons. This does not include red or brown hematite ores which were washed or hydraulicked, or any sulphurous or carbonate iron ores which were roasted at the mines where they were produced, nor does it include ore which had been cobbed or sorted at mines by hand.

## COMPARISONS WITH THE TENTH CENSUS.

Comparing the returns for the census year ended December 31, 1889, with those of the census year 1880, it is found that 7,120,362 long tons of ore were mined in 1880, valued at $23,156,957, while the census year 1889 shows an output of 14,518,041 long tons, valued at $33,351,978, an increase of 7,397,679 long tons, or 103.89 per cent, over the production of 1880, and an augmented value at the mines of $10,195,021, or 44.03 per cent.

The average value per ton of iron ore at the mines, excluding interest on invested capital, has been reduced from $3.25 per long ton in 1880 to $2.30 per ton in 1889. This is due to the increased average output for mining



RED HEMATITE MINING NEAR TOWER, MINNESOTA.

(See page 23.)

operation, and in a number of instances to the consolidation of several mines which have been grouped under one management, thus reducing the cost of superintendence, office force, administration, etc., encouraging the use of improved machinery, systematic and advanced methods of mining to meet the keener competition resulting from lower freight rates, improved facilities, such as shipping and receiving docks and special vessels or cars built for ore handling and transportation. The cost of mining large quantities of ore and new developments in some of the southern states also contributed to the diminution of the average value at the mines.

Iron ore was obtained from 23 states in 1880, and all of these, with the exception of Indiana and Vermont, were producers as reported to the Eleventh Census. To the states which mined ore as reported to the Tenth Census there are added Colorado, Idaho, Minnesota, Montana, New Mexico, Utah, and Washington as new producers for the Eleventh Census. Of these, Colorado and Minnesota were the only states which contributed largely to the output of 1889. California produced iron ores between the years 1880 and 1889, but none was reported in either of the years named. The states which have augmented the output of iron ore, including the new producers mentioned and those which show decreased production, and the percentages of such increase or decrease, are as follows:

### STATES AND TERRITORIES WITH AN INCREASED PRODUCT OF IRON ORE AT THE ELEVENTH CENSUS.

[Long tons.]

| STATES AND TERRITORIES. | 1889. | 1880. | Percentage of increase. | STATES AND TERRITORIES. | 1889. | 1880. | Percentage of increase. |
|---|---|---|---|---|---|---|---|
| Alabama | 1, 570, 319 | 171, 139 | 817. 57 | New Mexico and Utah (*a*) | 36, 050 | .......... | .......... |
| Colorado (*a*) | 109, 136 | .......... | .......... | New York | 1, 247, 537 | 1, 126, 899 | 10. 71 |
| Georgia and North Carolina | 258, 145 | 84, 584 | 205. 19 | Oregon and Washington | 26, 283 | *b* 6, 225 | 322. 22 |
| Idaho and Montana (*a*) | 24, 072 | .......... | .......... | Tennessee | 473, 294 | 93, 272 | 407. 43 |
| Kentucky | 77, 487 | 57, 865 | 33. 91 | Texas | 13, 000 | 3, 214 | 304. 48 |
| Michigan | 5, 856, 169 | 1, 640, 814 | 256. 91 | Virginia and West Virginia | 511, 255 | 217, 448 | 135. 12 |
| Minnesota (*a*) | 864, 508 | .......... | .......... | Wisconsin | 837, 399 | 37, 000 | 2, 163. 24 |

*a* Not reported at the Tenth Census as producing iron ore.

*b* For Oregon only; Washington not reported as a producer at the Tenth Census.

### STATES WITH A DECREASED OUTPUT OF IRON ORE AT THE ELEVENTH CENSUS.

[Long tons.]

| STATES. | 1889. | 1880. | Percentage of decrease. | STATES. | 1889. | 1880. | Percentage of decrease. |
|---|---|---|---|---|---|---|---|
| Connecticut, Maine, and Massachusetts | 88, 251 | 92, 549 | 4. 64 | New Jersey | 415, 510 | 676, 225 | 38. 55 |
| Delaware and Maryland | 29, 380 | 127, 102 | 76. 88 | Ohio | 254, 294 | 488, 753 | 47. 97 |
| Indiana (*a*) | .......... | 458 | .......... | Pennsylvania | 1, 560, 234 | 1, 951, 496 | 20. 05 |
| Missouri | 265, 718 | 344, 819 | 22. 94 | Vermont (*a*) | .......... | 500 | .......... |

*a* No report on iron ore mined was made for this state at the Eleventh Census.

## COMPARISON OF THE IRON ORE PRODUCT WITH OTHER CENSUS REPORTS.

An examination of the iron ore product of various states as reported at the censuses of 1880 and 1889 emphasizes the changes due to improved transportation facilities, larger smelting plants, and a development of the iron-ore industry in keeping with national advancement. This may be further illustrated by a table in which the various states are placed in their order of prominence as producers of iron ore in the Seventh, Eighth, Ninth, Tenth, and Eleventh Censuses. Up to 1850 little iron ore was transported except for such distances as could be conveniently covered by wagons. The blast furnaces and forges, depending chiefly on charcoal for fuel, were located close to their supplies of raw material.

The advance in the use of mineral fuel encouraged the erection of iron works at more convenient centers, but generally near ore deposits or within reach of them by water transportation; but in the subsequent development of the industry iron works were constructed where raw materials could be assembled advantageously and market facilities also secured. The report of 1870 indicated the growing use of railroads, which was greatly increased, as shown by the report of 1880, and the rank exhibited by the returns of 1889 illustrates to what an extent the appreciation of market facilities and the character of the ore have influenced consumers. In late years the growth of the bessemer steel industry and the demand of large blast furnace plants for quantities of ore are responsible for the exploitation of numerous iron-ore mines on a scale not previously attempted, and the transportation of vast volumes of mineral over great distances.

The table following gives the rank of states as producers of iron ore in the census years 1850, 1860, 1870, 1880, and 1889. 2 states produced over 100,000 long tons of iron ore in 1850. This number was increased to 5 states in 1860, to 7 in 1870, to 9 in 1880, and to 13 in 1889. 1 state exceeded 500,000 tons in 1850 and 1860, 2 in 1870, 4 in 1880, and 6 in 1889. Pennsylvania is the only state reported as reaching an output exceeding 1,000,000 tons until 1880, when 3 states exceeded this amount, and in 1889 4 states were numbered among the great producers. In 1870 and 1880 Pennsylvania reported about 2,000,000 tons, but in 1889 fell below that figure. In the latter year Michigan produced nearly 6,000,000 tons. In the census reports for 1850, 1860, and 1870 the statistics of the production of iron ore were obtained largely from reports made by the various blast furnaces as to the amount of ore consumed; the tables did not specify in what states the ore was produced, but merely gave the amounts reported as being used by blast furnaces. It was, however, deemed advisable, except where reliable local statistics were accessible, to use the data as given in previous census reports, although in several instances states are evidently placed in positions different from that which they should actually assume as producers of iron ores, particularly in the Ninth Census. As iron ores were used elsewhere than at blast furnaces, the error can not be corrected by states, for the record shows that the blast furnaces in 1860 used 2,309,975 short tons, and, in addition, 908,300 short tons were produced by mining companies, making a total of 3,218,275 short tons, but no distribution of the ore to points of production is mentioned.

RANK OF STATES AS PRODUCERS OF IRON ORES IN THE CENSUS YEARS.

| 1850. | 1860. | 1870. | 1880. | 1889. | |
|---|---|---|---|---|---|
| 1 Pennsylvania. | 1 Pennsylvania. | 1 Pennsylvania. | 1 Pennsylvania. | 1 Michigan. | |
| 2 Ohio. | 2 Ohio. | 2 Michigan. | 2 Michigan. | 2 Alabama. | |
| 3 Maryland. | 3 New York. | 3 Ohio. | 3 New York. | 3 Pennsylvania. | |
| 4 Tennessee. | 4 New Jersey. | 4 New York. | 4 New Jersey. | 4 New York. | 1,000,000 |
| 5 Kentucky. | 5 Michigan. | 5 Maryland. | 5 Ohio. | 5 Minnesota. | |
| 6 Virginia. | 6 Kentucky. | 6 Kentucky. | 6 Missouri. | 6 Wisconsin. | 500,000 |
| 7 New Jersey. | 7 Maryland. | 7 Missouri. | 7 Alabama. | 7 Virginia. | |
| 8 New York. | 8 Tennessee. | 8 New Jersey. | 8 Virginia. | 8 Tennessee. | |
| 9 Missouri. | 9 Massachusetts. | 9 Tennessee. | 9 Maryland. | 9 New Jersey. | |
| 10 Connecticut. | 10 Missouri. | 10 Indiana. | 10 Tennessee. | 10 Missouri. | |
| 11 Massachusetts. | 11 Virginia. | 11 Wisconsin. | 11 Georgia. | 11 Ohio. | |
| 12 Vermont. | 12 Connecticut. | 12 Virginia. | 12 Kentucky. | 12 Georgia. | |
| 13 Illinois. | 13 Wisconsin. | 13 Connecticut. | 13 Massachusetts. | 13 Colorado. | 100,000 |
| 14 Indiana. | 14 Illinois. | 14 West Virginia. | 14 West Virginia. | 14 Kentucky. | 50,000 |
| 15 Georgia. | 15 Alabama. | 15 Massachusetts. | 15 Wisconsin. | 15 Massachusetts. | |
| 16 Wisconsin. | 16 Vermont. | 16 Alabama. | 16 Connecticut. | 16 New Mexico. | |
| 17 Maine. | 17 Georgia. | 17 North Carolina. | 17 Oregon. | 17 Connecticut. | |
| 18 Michigan. | 18 Indiana. | 18 Vermont. | 18 Maine. | 18 Maryland. | |
| 19 Alabama. | | 19 Georgia. | 19 Texas. | 19 Oregon. | |
| 20 North Carolina. | | 20 Mississippi. | 20 North Carolina. | 20 Montana. | |
| 21 New Hampshire. | | 21 South Carolina. | 21 Delaware. | 21 West Virginia. | |
| | | | 22 Vermont. | 22 Texas. | |
| | | | 23 Indiana. | 23 Maine. | |
| | | | | 24 North Carolina. | |
| | | | | 25 Utah. | |
| | | | | 26 Delaware. | |
| | | | | 27 Idaho. | |
| | | | | 28 Washington. | |

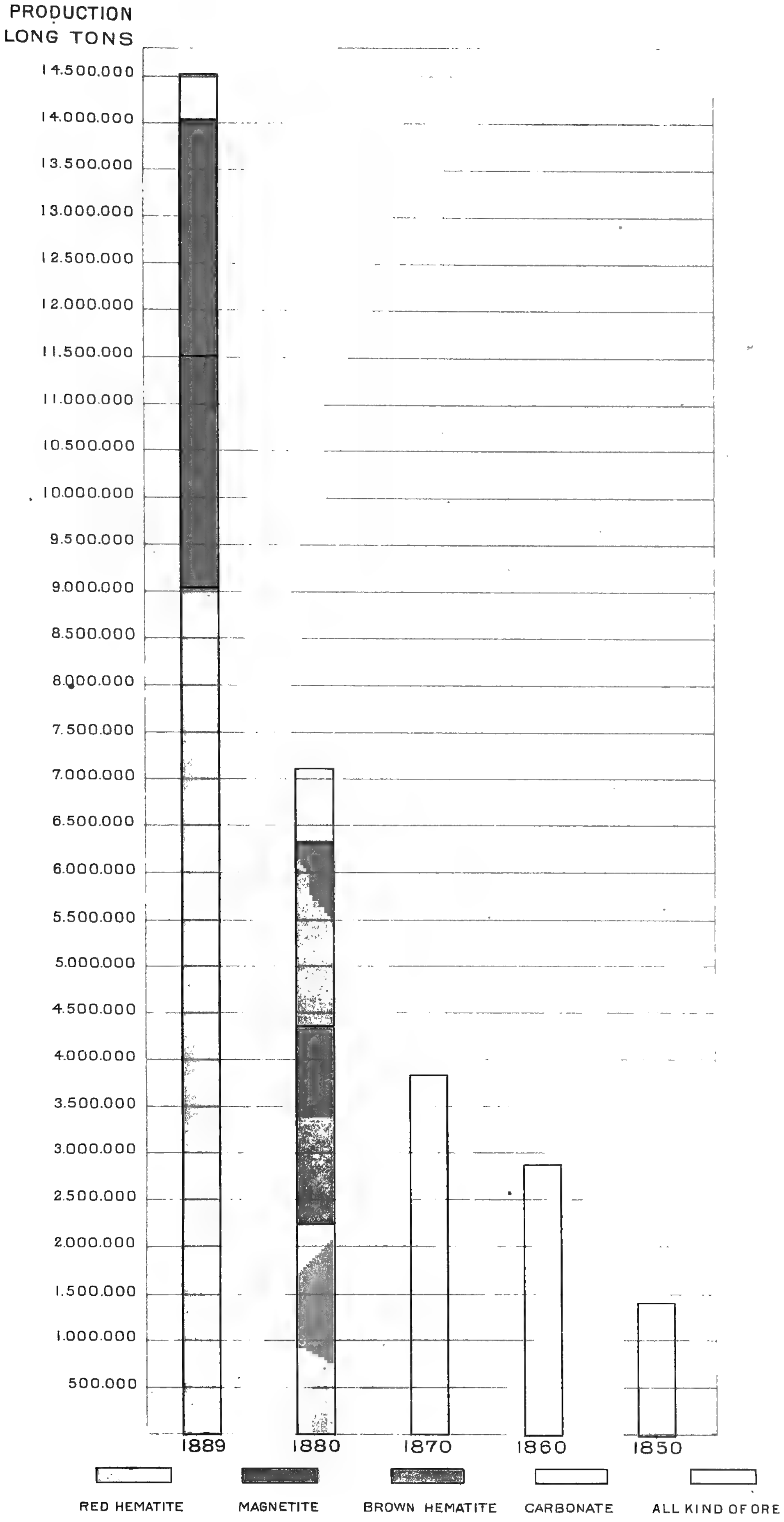
## CAPITAL.

The total value of the iron-ore mines in the United States December 31, 1889, was $109,766,199, as against $61,782,287 invested in 1880 in regular mining establishments, an increase of $47,983,912, or 77.67 per cent, divided as follows:

TOTAL VALUE OF THE IRON-ORE MINES IN THE UNITED STATES.

| ITEMS. | 1889. | 1880. |
|---|---|---|
| Total | $109,766,199 | $61,782,287 |
| Land | 78,474,881 | 48,274,149 |
| Buildings and fixtures | 7,673,520 | 8,657,375 |
| Tools, implements, live stock, machinery, etc | 8,045,545 | |
| Cash and stock on hand | 15,572,253 | 4,850,763 |

The state of Michigan has advanced from second place in 1880, with a total reported capital of $17,496,775, to first position in 1889, with an investment of $41,958,571, an increase of $24,461,796, or nearly 140 per cent. The iron-ore mines of Michigan therefore represent 38.23 per cent of the total capital employed in iron-ore mining in the United States, subdivided as shown in the table on the following page.



TOTAL PRODUCT OF IRON ORES IN 1889, 1880, 1870, 1860 AND 1850. SEE PAGES 12-14.

VALUE OF IRON-ORE MINES IN MICHIGAN.

| ITEMS. | 1889. | 1880. |
|---|---|---|
| Total | $41, 958, 571 | $17, 496, 775 |
| Land | 27, 032, 732 | 12, 452, 311 |
| Buildings and fixtures | 2, 819, 107 | 2, 789, 944 |
| Tools, implements, live stock, machinery, etc | 3, 732, 410 | |
| Cash and stock on hand | 8, 374, 322 | 2, 254, 520 |

Pennsylvania occupies second place, with a valuation of $16,249,313, or 14.80 per cent of the total, a decrease of $1,372,388, or 7.79 per cent from the 1880 valuation of $17,621,701, when it occupied first place.

New York follows next, having the same relative rank as in 1880, with $12,489,481, or 11.38 per cent of the total valuation for the United States, an increase in capital of $4,226,342, or 51.15 per cent.

Minnesota, which produced no ore in 1880, Alabama, Missouri, and Wisconsin follow in the order named, the last 3 occupying, respectively, ninth, fifth, and fourteenth places in 1880.

The valuation of the iron-ore mines of the above 7 states as reported is $93,422,218, or 85.11 per cent of the total capital invested in ore mining in 1889.

The following table shows, by states and territories, the amount and distribution of capital invested in iron-ore mining in the year 1889, as reported by the various individuals, firms, or companies to the Census Office:

CAPITAL INVESTED IN IRON-ORE MINING IN 1889, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | Total. | Land. | Buildings and fixtures. | Tools, implements, live stock, machinery, etc. | Cash and stock on hand. | Total capital invested in mines in 1880. |
|---|---|---|---|---|---|---|
| Total | $109, 766, 199 | $78, 474, 881 | $7, 673, 520 | $8, 045, 545 | $15, 572, 253 | $61, 782, 287 |
| Alabama | 5, 244, 906 | 4, 258, 645 | 306, 713 | 382, 548 | 297, 000 | 536, 442 |
| Colorado | 2, 480, 445 | 2, 241, 672 | 69, 015 | 74, 948 | 94, 810 | .............. |
| Connecticut, Maine, and Massachusetts | 551, 365 | 322, 240 | 97, 743 | 66, 163 | 65, 219 | 708, 800 |
| Delaware and Maryland | 355, 074 | 223, 075 | 35, 500 | 65, 450 | 31, 049 | 538, 814 |
| Georgia and North Carolina | 1, 634, 434 | 1, 230, 430 | 194, 148 | 149, 422 | 60, 434 | 184, 225 |
| Idaho and Montana | 342, 879 | 301, 500 | 4, 600 | 11, 350 | 25, 429 | .............. |
| Kentucky | 405, 868 | 302, 201 | 23, 237 | 16, 712 | 63, 718 | 779, 829 |
| Michigan | 41, 958, 571 | 27, 032, 732 | 2, 819. 107 | 3, 732, 410 | 8, 374, 322 | 17, 496, 775 |
| Minnesota | 8, 481, 282 | 4, 280, 000 | 526. 504 | 451, 904 | 3, 222, 874 | .............. |
| Missouri | 4, 613, 396 | 3, 531, 817 | 95, 569 | 178, 335 | 807, 675 | 5, 598, 556 |
| New Jersey | 3, 168, 891 | 2, 180, 380 | 194, 564 | 349, 944 | 444, 003 | 6, 201, 761 |
| New Mexico and Utah | 152, 000 | 139, 000 | 8, 500 | 2, 500 | 2, 000 | .............. |
| New York | 12, 489, 481 | 9, 093, 455 | 1, 603, 982 | 990, 364 | 801, 680 | 8, 263, 139 |
| Ohio | 1, 311, 918 | 917, 035 | 135, 375 | 64, 675 | 194, 833 | 1, 248, 725 |
| Oregon and Washington | 86, 285 | 56, 630 | 6, 396 | 19, 409 | 3, 850 | 16, 975 |
| Pennsylvania | 16, 249, 313 | 14, 812, 357 | 547, 010 | 639, 427 | 250, 519 | 17, 621, 701 |
| Tennessee | 1, 897, 895 | 1, 394, 774 | 185, 314 | 253. 206 | 64, 601 | 473, 920 |
| Texas | 51, 678 | 45, 500 | .............. | 2, 620 | 3, 558 | .............. |
| Vermont | .............. | .............. | .............. | .............. | .............. | 2, 000 |
| Virginia and West Virginia | 3, 905, 249 | 2, 881, 441 | 567, 544 | 253, 195 | 203, 069 | 1, 924, 625 |
| Wisconsin | 4, 385, 269 | 3, 229, 997 | 252, 699 | 340, 963 | 561, 610 | 186, 000 |

The inquiry concerning the capital invested in iron-ore mines has presented difficulties which made it practically impossible in many cases to obtain valuations on the basis of the questions presented in the schedules prepared by the Census Office. In the Lake Superior region a large proportion of the mines are leased, and in other districts mines are worked under leases, a stipulated sum per ton, with a minimum yearly royalty provision, being paid to the owners of the fee. The lessor in a majority of instances owns tracts of greater or less extent as yet unproved, of which the mines occupy but a limited portion. Some of the large deposits in other sections have been in the hands of the present owners for a number of years, and have grown from small operations to great enterprises. During this time no actual appraisement of values has been made, as the properties have not been offered for sale, nor have propositions of purchase been entertained. In these instances the assessors' valuation gave an approximate basis for formulating an estimate.

A number of iron-ore mines are connected with blast furnace plants, and the properties are valued as entire enterprises, no division of the capitalization being attempted by the owners. Other properties have the ore distributed over large areas, from which it is won by stripping or benching, and in some of these the value is partly dependent upon a deposit of coal lying close to the iron ore. Similarly, the timber upon some areas worked for iron ore affects the valuation. An attempt has been made, where valuations could not be reported, to arrive at a basis of estimate by using the rate of tax assessment, or by calculating a value by capitalizing an assumed royalty, necessarily depending upon the location and character of the ore, multiplied by the product for the year 1889. This explanation will indicate that the capital invested, as reported in the table, is considerably less than that actually employed in the mining of iron ore, but it is as close an approximation as can be made.

The total capital as given in this report does not include the cost of shipping and receiving docks, built and maintained solely for handling iron ores, nor the equipment of locomotives, cars, and tram roads, or of steam vessels which are devoted exclusively to the iron-ore trade. Exceptions are made in a few cases where the handling facilities are within the property actually exploited. Mention of the ore docks, etc., and notes of some of the railway equipment appear under the head of "Transportation and handling iron ores," page 26.

An instance of liberal expenditure for the development of iron-ore mines is in the construction and equipment of a standard gauge railroad from Lake Superior for 70 miles through an uninhabited country in Minnesota to the deposit of iron ore near Lake Vermilion, and the subsequent extension of this road 30 miles to other deposits. The equipment of cars, docks, etc., mentioned under the subhead of "Shipping docks", the locomotives, the buildings, and the entire expenditure for locating and constructing this railroad were solely for the purpose of developing the iron-ore mines, and the handling of iron ore to-day represents the business done by this line of transportation. Millions of dollars returned in the census figures of railway and vessel transportation, and also for workmen's homes, could with propriety be added to the capital demanded for the iron-ore mining industry.

## LABOR AND WAGES.

Returns show that the mining of iron ore gave continuous employment directly to 38,227 persons engaged in or immediately at the mines, an increase of 6,559 men, or 20.71 per cent, over the Tenth Census, when the number was 31,668 engaged in work connected with breaking down, raising, and delivering the ore in cars or carts or on stock piles at the mines. This force in 1889 was divided as follows: 1,366 foremen (680 employed above and 686 below ground), 2,079 mechanics, 12,432 miners, 21,010 laborers (14,531 above and 6,479 below ground), 820 boys (709 being employed above and 111 below ground), and 520 men in offices. Omitting the latter, the total number actually employed in handling the ore was 37,707, and the amount paid in wages direct to miners and mining contractors reached a total of $15,458,118. This shows an average earning capacity for each man so employed of $409.95 per annum, including the contractors' profits and the additional pay allowed to foremen. This is an increase over the figures for 1880 of $101.01 per annum, or 32.7 per cent, which is due principally to the fact that a larger number of the mines are now wrought under ground, permitting the men to be constantly employed throughout the year and demanding better skill.

Allowing for Sundays and holidays, necessary stoppages of machinery for repairs, and for personal loss of time by employés by reason of illness, etc., it is found in practice that in the trades or employments where continuous labor is possible in protected buildings or mines full time approximates 24 days per month or 288 days per annum. The average total days worked by employés in mining iron ore during the year 1889 amounted to 247 per annum, notwithstanding that in open pit mining operations are largely suspended during inclement weather, and at some of the underground mines the working force is considerably reduced during the winter months, as the ore is stocked. The number of individuals who obtained employment in iron-ore mines exceeded the figures given, as the inquiries covering the labor in mining was formulated as follows: average number employed, average wages per day, and average number of days worked per year; otherwise the total number of employés would have been much greater.

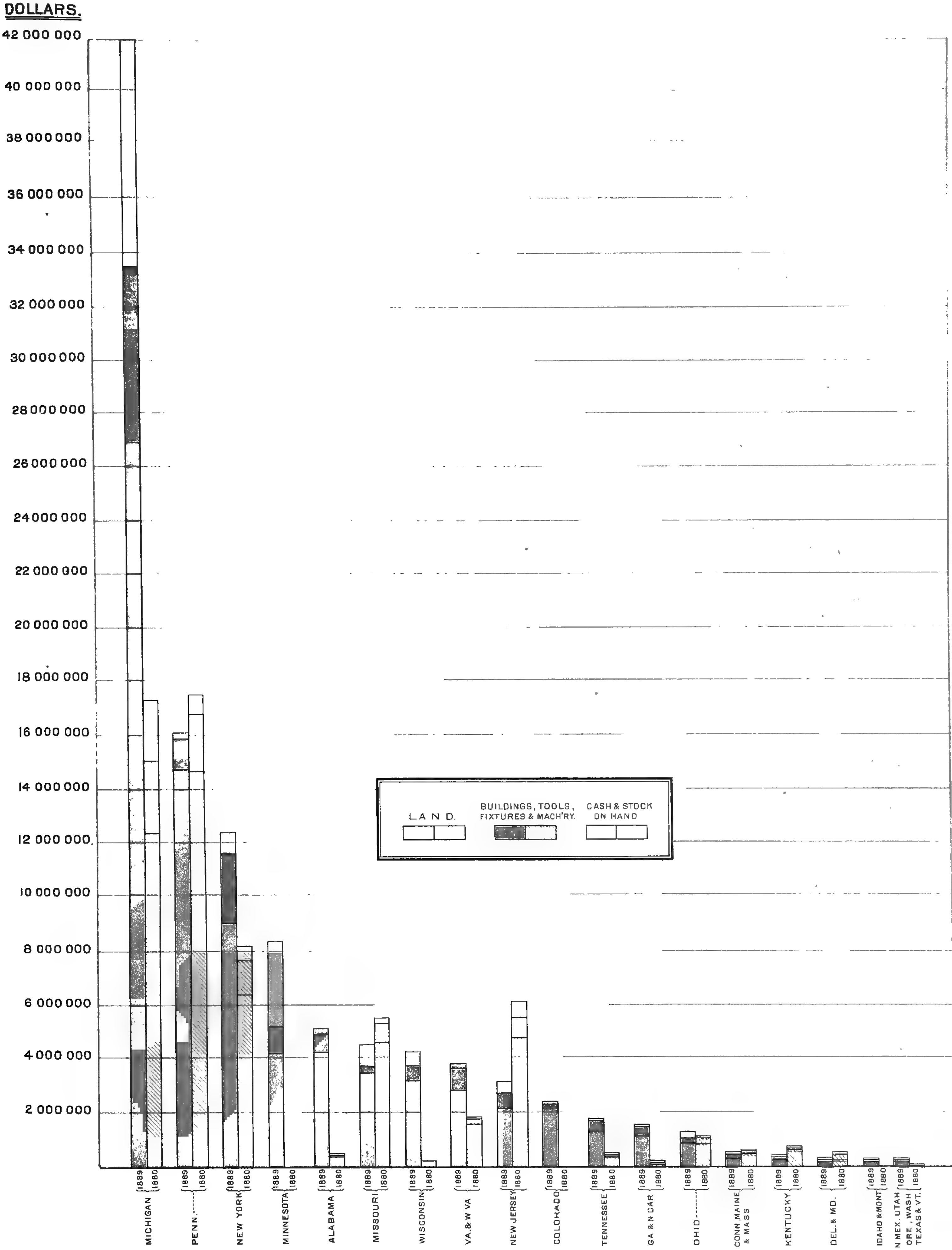
The compensation paid the 520 persons employed in offices at the mines amounted in the aggregate to $529,043, an average annual earning of $1,017.39. The office force above mentioned does not include officers, agents, or employés connected with general offices at commercial centers, where accounts are kept or sales and collections made, nor does it include the ore samplers or inspectors employed at shipping or distributing points. The inquiry as to labor and wages does not extend beyond the working force at the mine.

The following statement shows the expenditure per ton of iron ore won for labor above and below ground in 1889 at the mines in the various states and territories, not including the compensation paid officers or office attendants, but including contractors' profits:

AVERAGE EXPENDITURES FOR WAGES PER LONG TON OF IRON ORE.

| | | | |
|---|---|---|---|
| The United States | $1.06 | Missouri | $0.97 |
| | | New Jersey | 1.71 |
| Alabama | 0.69 | New Mexico and Utah | 1.22 |
| Colorado | 2.48 | New York | 1.00 |
| Connecticut, Maine, and Massachusetts | 1.82 | Ohio | 1.40 |
| Delaware and Maryland | 1.65 | Oregon and Washington | 1.20 |
| Georgia and North Carolina | 0.71 | Pennsylvania | 0.75 |
| Idaho and Montana | 2.21 | Tennessee | 0.76 |
| Kentucky | 0.87 | Texas | 0.91 |
| Michigan | 1.19 | Virginia and West Virginia | 1.09 |
| Minnesota | 1.10 | Wisconsin | 1.09 |

It will be seen that the lowest expenditure for labor per ton of ore at the mines was in the states of Alabama and Georgia and North Carolina, where it amounted to 69 and 71 cents per ton, respectively, due to large open workings and modern and systematic systems of mining, and in Alabama and Georgia to the soft character of the ore, etc.



CAPITAL USED IN IRON ORE PRODUCTION IN EACH STATE IN 1889 AND 1880. SEE PAGES 14 AND 16.

In Pennsylvania one-half of the iron ore credited to the state comes from the Cornwall ore hills, where the soft character of the magnetite and its accessibility assist in reducing the average cost of labor employed in mining for the entire state to 75 cents per long ton. The expense of mining the hard Lake Superior ores is best illustrated in the state of Michigan, where $1.19 was expended for wages at the mines per ton of ore won. The cost in Colorado, Idaho, and Montana is due to the higher rates of wages prevailing in those states and the small amount of ore won.

In the New England states, New Jersey, Ohio, Delaware, and Maryland the exploitation of old workings or of scattered deposits causes a high cost per ton for wages. The use of improved machinery and the predominance of large mines assist in reducing the cost for labor in Wisconsin, Minnesota, Alabama, New York, and other states, and the partial employment of convicts in Tennessee, Texas, and Georgia affects the figures for these states.

In order to obtain the average wages paid the men in the different classes and the average number of days which they worked during the year, the average number of each class of men employed in each mine was multiplied by the average number of days worked during the year at that mine, thus giving the total number of days made by each of the different classes of men. These products, multiplied by the average wages per day paid to each class at the various mines, gave the total amount of wages earned. Adding the totals for the different mines and classes gave the grand total for each state or district, and dividing the total number of days worked by each class by the total number of workmen in the subdivision gave the average number of days made by each workman in that class during the year, and the total number of days worked divided into the calculated wages gave very closely the average wages paid to each man per day.

In this manner it has been possible to calculate the average wages and the average number of days worked by each class for the various states, and also the average for the United States. Tables are appended which will be found to agree closely with the amounts actually paid to the various workmen and contractors, any differences being due to the fact that, where a large number of men are employed at various wages and for different times, it is impossible to have the calculated and actual wages paid agree exactly, and also because a certain amount representing contractors' profit is not included in the average wages.

The 680 foremen above ground received wages averaging from $1.25 per day in Kentucky to $4.88 per day in Colorado, the mean for the United States being $2.40, and the average number of days during the year which they worked 258. The total calculated wages which they received amounted to $421,610. The mechanics' wages varied from $0.50 per day in Texas, where convict labor was employed, to $3.86 per day in Colorado, the average for the entire country being $1.90, and the average number of days worked during the year 274. The total calculated wages which were received by mechanics during the year 1889 was $1,080,406. The average wages received by the 14,531 laborers employed above ground was $1.29, ranging from $0.53 in Texas to $3.50 in New Mexico and Utah. These laborers worked on an average 228 days during the year, and received a total compensation of $4,277,199. The 709 boys under 16 years of age received a total compensation of $97,279, and worked 221 days during the year. They therefore received an average of $0.62 per day, the wages varying from $0.49 in Missouri to $2 in Colorado.

EMPLOYÉS AT IRON-ORE MINES IN 1889.

| STATES AND TERRITORIES. | Total number employés above and below ground. | ABOVE GROUND. | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total number employés. | Foremen and overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | | |
| | | | Number employed. | Average wages per day. | Average number of days worked. | Number employed. | Average wages per day. | Average number of days worked. | Number employed. | Average wages per day. | Average number of days worked. | Number employed. | Average wages per day. | Average number of days worked. |
| Total | 37,707 | 17,999 | 680 | $2.40 | 258 | 2,079 | $1.90 | 274 | 14,531 | $1.29 | 228 | 709 | $0.62 | 221 |
| Alabama | 3,081 | 1,762 | 54 | 2.36 | 259 | 79 | 1.94 | 241 | 1,533 | 1.20 | 227 | 96 | 0.53 | 236 |
| Colorado | 391 | 143 | 14 | 4.88 | 177 | 26 | 3.86 | 219 | 101 | 2.99 | 186 | 2 | 2.00 | 74 |
| Connecticut, Maine, and Massachusetts | 424 | 183 | 8 | 2.44 | 313 | 26 | 1.65 | 308 | 149 | 1.36 | 277 | ...... | ...... | ...... |
| Delaware and Maryland | 232 | 232 | 10 | 1.52 | 224 | ...... | ...... | ...... | 208 | 1.00 | 200 | 14 | 0.57 | 225 |
| Georgia and North Carolina | 780 | 675 | 41 | 1.93 | 214 | 24 | 1.49 | 214 | 573 | 1.03 | 208 | 37 | 0.57 | 219 |
| Idaho and Montana | 88 | 70 | 5 | 3.15 | 253 | 1 | 3.00 | 150 | 64 | 3.03 | 171 | ...... | ...... | ...... |
| Kentucky | 375 | 375 | 5 | 1.25 | 212 | 5 | 1.50 | 275 | 340 | 1.03 | 180 | 25 | 0.75 | 212 |
| Michigan | 12,947 | 4,081 | 147 | 2.98 | 289 | 948 | 2.00 | 285 | 2,904 | 1.60 | 255 | 82 | 0.83 | 283 |
| Minnesota | 1,755 | 742 | 21 | 3.27 | 276 | 93 | 2.26 | 276 | 611 | 1.90 | 233 | 17 | 0.86 | 219 |
| Missouri | 706 | 373 | 11 | 2.10 | 297 | 41 | 1.80 | 289 | 310 | 1.20 | 254 | 11 | 0.49 | 253 |
| New Jersey | 1,872 | 492 | 24 | 2.61 | 308 | 152 | 1.48 | 280 | 289 | 1.21 | 272 | 27 | 0.62 | 274 |
| New Mexico and Utah | 47 | 12 | 2 | 3.75 | 306 | ...... | ...... | ...... | 10 | 3.50 | 286 | ...... | ...... | ...... |
| New York | 3,132 | 1,348 | 50 | 2.44 | 296 | 257 | 1.66 | 293 | 1,020 | 1.20 | 268 | 21 | 0.64 | 264 |
| Ohio | 1,610 | 842 | 36 | 1.93 | 264 | 42 | 1.44 | 223 | 755 | 1.03 | 186 | 9 | 0.59 | 154 |
| Oregon and Washington | 47 | 12 | 1 | 4.50 | 273 | 4 | 3.50 | 273 | 7 | 2.44 | 252 | ...... | ...... | ...... |
| Pennsylvania | 4,370 | 3,038 | 110 | 1.69 | 241 | 159 | 1.70 | 240 | 2,599 | 1.10 | 214 | 170 | 0.56 | 207 |
| Tennessee | 1,515 | 1,313 | 32 | 2.15 | 259 | 31 | 1.93 | 257 | 1,162 | 1.05 | 217 | 88 | 0.58 | 245 |
| Texas | 87 | 87 | 2 | 2.29 | 170 | 2 | 0.50 | 224 | 82 | 0.53 | 253 | 1 | 0.50 | 44 |
| Virginia and West Virginia | 2,436 | 1,666 | 86 | 1.98 | 210 | 74 | 1.65 | 183 | 1,402 | 1.02 | 201 | 104 | 0.52 | 146 |
| Wisconsin | 1,817 | 553 | 21 | 2.77 | 262 | 115 | 2.09 | 292 | 412 | 1.68 | 257 | 5 | 1.20 | 265 |

EMPLOYÉS AT IRON-ORE MINES IN 1889—Continued.

| STATES AND TERRITORIES. | BELOW GROUND. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total number employés. | Foremen and overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | |
| | | Number employed. | Average wages per day. | Average number of days worked. | Number employed. | Average wages per day. | Average number of days worked. | Number employed. | Average wages per day. | Average number of days worked. | Number employed. | Average wages per day. | Average number of days worked. |
| Total | 19,708 | 686 | $2.46 | 282 | 12,432 | $1.91 | 261 | 6,479 | $1.60 | 261 | 111 | $0.82 | 216 |
| Alabama | 1,319 | 8 | 2.95 | 274 | 598 | 1.92 | 245 | 706 | 1.47 | 256 | 7 | 0.67 | 161 |
| Colorado | 248 | 11 | 3.99 | 233 | 205 | 3.00 | 248 | 29 | 2.68 | 208 | 3 | 1.69 | 129 |
| Connecticut, Maine, and Massachusetts | 241 | 8 | 2.13 | 256 | 193 | 1.40 | 257 | 40 | 1.33 | 264 | | | |
| Delaware and Maryland | | | | | | | | | | | | | |
| Georgia and North Carolina | 105 | 3 | 2.12 | 308 | 10 | 1.20 | 202 | 91 | 0.68 | 297 | 1 | 0.40 | 244 |
| Idaho and Montana | 13 | 2 | 3.69 | 180 | 11 | 3.14 | 162 | | | | | | |
| Kentucky | | | | | | | | | | | | | |
| Michigan | 8,866 | 304 | 2.69 | 291 | 5,341 | 2.23 | 274 | 3,199 | 1.73 | 272 | 22 | 1.17 | 277 |
| Minnesota | 1,013 | 37 | 3.00 | 296 | 498 | 2.55 | 259 | 478 | 1.96 | 255 | | | |
| Missouri | 333 | 17 | 2.16 | 284 | 238 | 1.58 | 265 | 73 | 1.36 | 236 | 5 | 0.45 | 276 |
| New Jersey | 1,380 | 68 | 1.90 | 295 | 944 | 1.39 | 268 | 353 | 1.24 | 280 | 15 | 0.68 | 288 |
| New Mexico and Utah | 35 | | | | 35 | 3.50 | 259 | | | | | | |
| New York | 1,784 | 71 | 2.15 | 280 | 1,085 | 1.47 | 278 | 623 | 1.37 | 261 | 5 | 0.79 | 106 |
| Ohio | 768 | [illegible] | 1.95 | 222 | 674 | 1.25 | 192 | 60 | 1.25 | 161 | 25 | 0.51 | 100 |
| Oregon and Washington | 35 | | | | 35 | 2.56 | 235 | | | | | | |
| Pennsylvania | 1,332 | 41 | 1.67 | 224 | 1,065 | 1.39 | 230 | 216 | 1.12 | 227 | 10 | 0.90 | 300 |
| Tennessee | 202 | 5 | 3.04 | 214 | 176 | 1.20 | 204 | 20 | 1.00 | 288 | 1 | 1.00 | 200 |
| Texas | | | | | | | | | | | | | |
| Virginia and West Virginia | 770 | 43 | 1.74 | 252 | 514 | 1.13 | 252 | 201 | 1.00 | 176 | 12 | 0.50 | 262 |
| Wisconsin | 1,264 | 59 | 2.69 | 304 | 810 | 2.00 | 273 | 390 | 1.81 | 251 | 5 | 1.14 | 219 |

The number of foremen or overseers working under ground was 686, although at a number of mines foremen had direct charge both above and below ground, proportionate time being charged to each. They received in wages a total of $476,233, working on an average 282 days per year, and earned $2.46 per day. The highest average wages were paid in Colorado, viz, $3.99 per day, and the lowest in Pennsylvania, $1.67 per day. The 12,432 miners received $6,189,308 for their labor during the year, an average per man of $1.91 per day during the days worked, viz, 261. The wages ranged from $3.50 in New Mexico and Utah to $1.13 in Virginia and West Virginia. The highest wages paid laborers under ground was in Colorado, $2.68 per day, and the lowest in Georgia and North Carolina, $0.68 per day. In Georgia, however, some convict labor was employed, reducing the general average for the state. The 6,479 laborers under ground received as wages $2,716,424, working on an average 261 days per year, and earned an average of $1.60 per day. The 111 boys under ground received $19,617, working on an average 216 days and earning $0.82 per day.

Michigan, as the largest producer, requires the services of the greatest number of persons, viz, 13,120, or 34.32 per cent of all the employés at the iron-ore mines in the United States; Pennsylvania follows with 4,410 employés, or 11.54 per cent; New York ranks third, its iron-ore mining industry giving employment to 3,178 persons, or 8.31 per cent of the total number of employés, and Alabama occupies fourth place, which state reported a total of 3,122 employés, or 8.17 per cent. These 4 states had 23,830 persons, or 62.34 per cent of the total employed in their iron-ore mines. Omitting the office force, the same relative positions are held by the states named.

The number of persons employed above and below ground, that is, in actual mining, divided into the tons of iron ore produced in some of the important states, furnishes the data for the following table:

TONS OF IRON ORE PRODUCED PER EMPLOYÉ IN 1889.

[Long tons.]

| STATES. | Amount produced. | Number of employés above and below ground. | Tons of ore per employé. | STATES. | Amount produced. | Number of employés above and below ground. | Tons of ore per employé. |
|---|---|---|---|---|---|---|---|
| The United States | 14,518,041 | 37,707 | 385.02 | Virginia and West Virginia | 511,255 | 2,436 | 209.87 |
| | | | | Tennessee | 473,294 | 1,515 | 312.41 |
| Michigan | 5,856,169 | 12,947 | 452.32 | New Jersey | 415,510 | 1,872 | 221.96 |
| Alabama | 1,570,319 | 3,081 | 509.68 | Missouri | 265,718 | 706 | 376.37 |
| Pennsylvania | 1,560,234 | 4,370 | 357.03 | Georgia and North Carolina | 258,145 | 780 | 330.96 |
| New York | 1,247,537 | 3,132 | 398.32 | Ohio | 254,294 | 1,610 | 157.95 |
| Minnesota | 864,508 | 1,755 | 492.60 | Colorado | 109,136 | 391 | 279.12 |
| Wisconsin | 837,399 | 1,817 | 460.87 | | | | |

BROWN HEMATITE (BOG IRON ORE) MINING NEAR NEW BIRMINGHAM, TEXAS.

(See pages 21, 22.)

Alabama returns the largest output per employé per annum, Minnesota, Wisconsin, Michigan, New York, Missouri, Pennsylvania, Georgia and North Carolina, Tennessee, Colorado, New Jersey, Virginia and West Virginia, and Ohio following in the order named. The preceding table emphasizes the influence which large mines and improved mining appliances exert upon the labor requisite, and also shows the advantages which some of the newer developed sections have in mining iron ore at low cost.

## SUPPLIES AND OTHER EXPENDITURES.

The supplies and materials for mining iron ore were generally furnished by the owners or lessees of mines, but in some cases the amounts so expended could not be learned, as powder, fuel, tools, etc., were furnished by contractors, whose work had been completed and who were not accessible. A total of $4,998,988, or 34 cents per ton of iron ore mined, represents the average cost of supplies and materials per ton of iron ore won, a decrease of 12 cents per ton, or 26.09 per cent, from the figures for the Tenth Census, when the cost was 46 cents per long ton.

In the southern states the prevailing soft character of the ore and moderate depths of the workings reduce the cost of supplies and materials, while a larger quantity is required for winning the harder ores of the Lake Superior region, New York, and New Jersey from deeper mines. Thus in Alabama the amount expended for supplies and materials is but 8 cents per ton, while in Michigan it amounted to 41 cents, in New York 46 cents, and in New Jersey 76 cents.

Other expenditures reported include taxes and royalties amounting to $3,795,509. As royalty is only paid on a portion of the ore mined, and as the system of owners charging up a rate per ton against the mine as a sinking fund does not prevail to any great extent, it would be unfair to form any conclusions as to the average royalties, namely, so much per ton on the basis of the reports made.

## TOTAL COST OF MINING IRON ORE.

The following table shows the expenditures of all kinds in the production of iron ore in the United States in 1889:

EXPENDITURES AT IRON-ORE MINES IN 1889, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | OFFICE FORCE. |  | Grand total employés. | Grand total wages. | Amount paid for contract work during 1889. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|
|  | Number. | Amount of wages. |  |  |  |  |  |  |
| Total | 520 | $529, 043 | 38, 227 | $14, 409, 151 | $1, 578, 010 | $4, 998, 988 | $3, 795, 509 | $24, 781, 658 |
| Alabama | 41 | 37, 170 | 3, 122 | 1, 032, 392 | 87, 322 | 128, 924 | 38, 680 | 1, 287, 318 |
| Colorado | 23 | 26, 425 | 414 | 297, 297 | ............ | 58, 504 | 25, 327 | 381, 128 |
| Connecticut, Maine, and Massachusetts | 2 | 1, 200 | 426 | 161, 894 | ............ | 60, 939 | 18, 103 | 240, 936 |
| Delaware and Maryland | 1 | 1, 200 | 233 | 49, 416 | 400 | 5, 203 | 4, 436 | 59, 455 |
| Georgia and North Carolina | 16 | 14, 725 | 796 | 144, 921 | 54, 032 | 46, 004 | 50, 128 | 295, 085 |
| Idaho and Montana | ........ | ............ | 83 | 53, 112 | ............ | 15, 669 | 3, 295 | 72, 076 |
| Kentucky | 8 | 7, 500 | 383 | 72, 456 | 2, 248 | 4, 000 | 22, 094 | 100, 798 |
| Michigan | 173 | 217, 283 | 13, 120 | 6, 353, 741 | 834, 234 | 2, 402, 443 | 2, 528, 123 | 12, 118, 541 |
| Minnesota | 15 | 25, 299 | 1, 770 | 978, 483 | ............ | 419, 192 | 158, 340 | 1, 556, 015 |
| Missouri | 23 | 29, 874 | 729 | 283, 847 | 2, 934 | 45, 563 | 63, 623 | 395, 967 |
| New Jersey | 21 | 14, 440 | 1, 893 | 568, 591 | 157, 536 | 316, 199 | 96, 676 | 1, 139, 002 |
| New Mexico and Utah | 1 | 1, 000 | 48 | 45, 052 | ............ | 7, 822 | 3, 344 | 56, 218 |
| New York | 46 | 43, 050 | 3, 178 | 1, 087, 252 | 204, 969 | 572, 501 | 185, 679 | 2, 050, 401 |
| Ohio | 34 | 17, 560 | 1, 644 | 367, 855 | 4, 568 | 23, 929 | 28, 367 | 424, 719 |
| Oregon and Washington | ........ | ............ | 47 | 31, 542 | ............ | 4, 237 | 1, 041 | 36, 820 |
| Pennsylvania | 40 | 26, 814 | 4, 410 | 1, 141, 239 | 55, 425 | 299, 429 | 215, 036 | 1, 711, 129 |
| Tennessee | 19 | 12, 460 | 1, 534 | 355, 332 | 17, 551 | 86, 318 | 49, 666 | 508, 867 |
| Texas | 2 | 365 | 89 | 12, 188 | ............ | 987 | 440 | 13, 615 |
| Virginia and West Virginia | 32 | 23, 257 | 2, 468 | 575, 061 | 7, 936 | 128, 323 | 128, 452 | 839, 772 |
| Wisconsin | 23 | 29, 421 | 1, 840 | 797, 480 | 148, 855 | 372, 802 | 174, 659 | 1, 493, 796 |

The total cost of the ore mined, as represented by schedules returned, aggregates $24,781,658, equivalent to an average cost of $1.71 per ton of ore mined, against $2.21 in 1880, a decrease of 50 cents per ton, or 22.62 per cent. The cost similarly determined for each state is set forth in the statement on the following page, which can be compared with the table on page 16, showing the expenditure for labor per ton of iron ore produced, and also with the table on page 18, indicating the quantity of ore won per employé. The difference includes more than supplies and materials. These figures indicate the advance made in labor-saving appliances and improved facilities for mining and handling the product of the mines. In the total cost of producing iron ore, and delivering it on cars or carts at the mines, Alabama is the only state which averages less than $1 per ton, viz, 82 cents. Next in order of low cost come Texas, $1.05; Tennessee, $1.08; Pennsylvania, $1.10; Georgia and North Carolina, $1.14. In Colorado, for reasons before given, the cost of producing one long ton of ore, $3.49, is greater than in any other state.

TOTAL COST OF PRODUCING ONE LONG TON OF IRON ORE IN THE VARIOUS STATES AND TERRITORIES.

| | |
|---|---|
| The United States | $1.71 |
| Alabama | 0.82 |
| Colorado | 3.49 |
| Connecticut, Maine, and Massachusetts | 2.73 |
| Delaware and Maryland | 2.02 |
| Georgia and North Carolina | 1.14 |
| Idaho and Montana | 2.99 |
| Kentucky | 1.30 |
| Michigan | 2.07 |
| Minnesota | 1.80 |
| Missouri | $1.49 |
| New Jersey | 2.74 |
| New Mexico and Utah | 1.56 |
| New York | 1.64 |
| Ohio | 1.67 |
| Oregon and Washington | 1.40 |
| Pennsylvania | 1.10 |
| Tennessee | 1.08 |
| Texas | 1.05 |
| Virginia and West Virginia | 1.64 |
| Wisconsin | 1.78 |

The costs do not include interest on capital invested, expenses of marketing the ore, or the maintenance of administrative offices elsewhere than at the mines.

The figures in the table on page 4 give the total value of the iron ore product at the mines in the year 1889 as $33,351,978, and the table of expenditures shows that the total cost of mining during the same year was $24,781,658, indicating an apparent profit of $8,570,320, or 34.58 per cent of the total expenditure during the year for labor, supplies and materials, superintendence, incidentals, taxes, etc., and also in some cases royalties. But in addition to these expenses there are interest on capital invested, royalties, cost of betterments, renewals, replacements, and additions to machinery, fixtures, live stock, general management and offices, sinking fund, etc., to be accounted for.

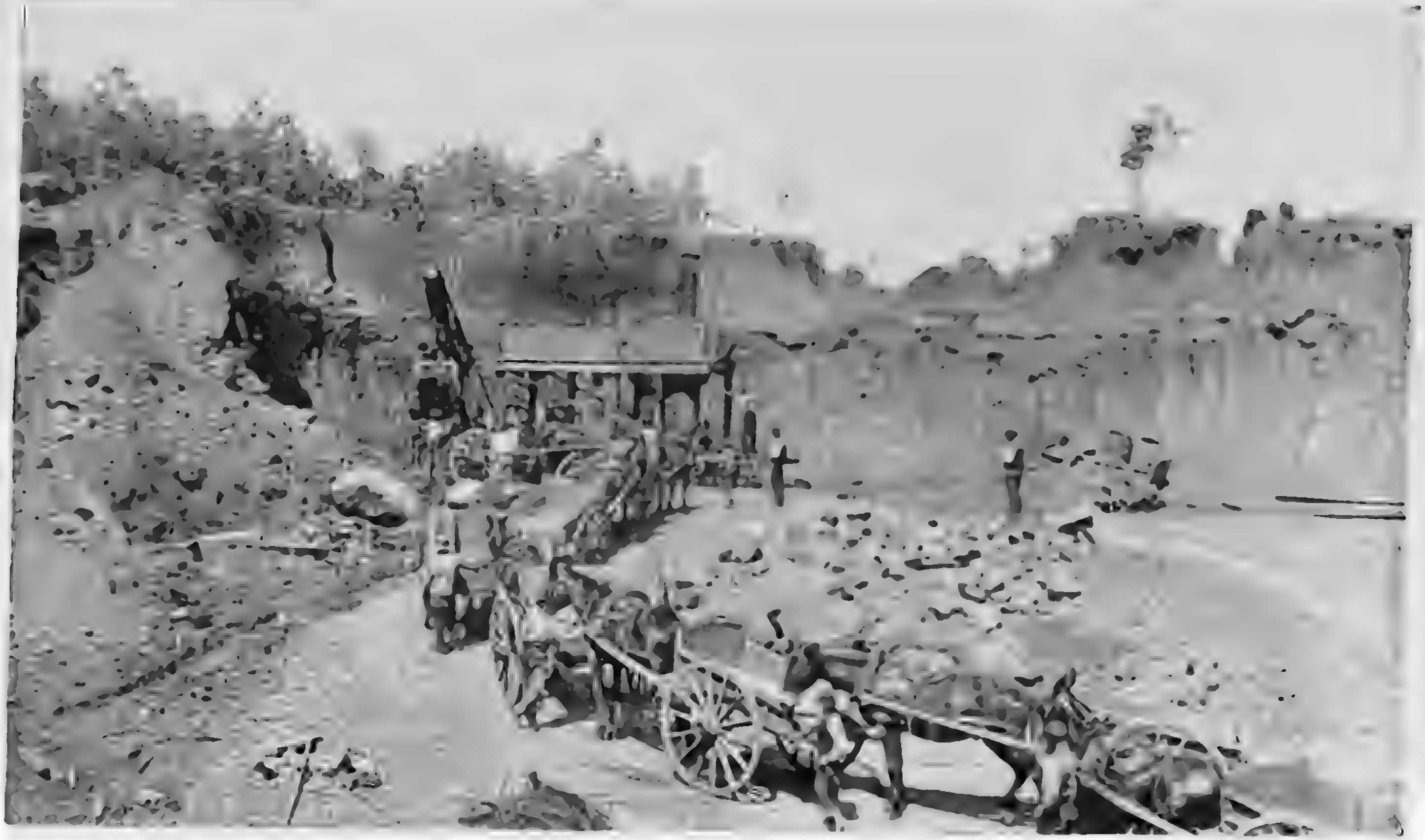
The apparent profit of $8,570,320 represents 7.81 per cent of the total capital invested, viz, $109,766,199, but from this apparent profit allowances for depreciation, betterments, general management, etc., must be made, and, as before mentioned, the total capital reported is below that actually employed, the average investment in iron-ore mining will therefore appear to yield less satisfactory results than the figures above given suggest.

## POWER USED IN IRON-ORE MINING IN THE UNITED STATES.

The schedules returned from the various active iron-ore mines report a total of 1,109 steam boilers, with an aggregate horse power of 57,976. These boilers furnished steam to 1,093 steam engines, including air compressors, hoisting machinery, engines for driving washers, crushers, etc., some of which are of large size. The steam engines reported, however, do not in most instances include the motive power for pumps, because pumps are rated independently of steam engines, as a locomotive would be. As the printed inquiry did not specifically cover this point, it was thought best not to follow it in detail as far as pumps were concerned. In the returns made, however, there were 79 pumps mentioned independent of steam engines; also 20 locomotives, used in and about the mines; 4 steam shovels, employed in digging or handling ore or stripping; 8 turbine wheels driving machinery, and 10 air compressors worked by water power. The application of steam and compressed air has largely reduced the number of animals employed in and about iron-ore mines, and as the queries in the census schedules especially provided for the value of the ore delivered on cars or carts at the mine, only animals actually employed in the mines were enumerated.

Michigan, as the largest producer of iron ore, and having numerous deep mines, has the greatest number of steam engines, a total of 387 engines, etc., and an aggregate of 332 boilers being in use, with a total of 24,180 horse power. As most of the iron ore obtained in Michigan is from underground workings (and there they are the deepest in the country), it is not surprising that 41.71 per cent of the total horse power of boilers connected with active iron-ore mines is utilized in that state.

Much of the iron ore of Alabama, Georgia, and Tennessee is from open cuts or from new exploitations. Therefore the large output of these states was won with a comparatively small number of steam engines and boilers. On the other hand, New York, New Jersey, and Pennsylvania obtained a large portion of their ores from underground operations, which had been worked for many years, requiring a greater proportion of power than in some other states.



BROWN HEMATITE MINING WITH STEAM SHOVEL, NEAR ANNISTON, ALABAMA. (See page 82.)

The following table shows the power used in the mining of iron ores during the year 1889:

### POWER USED IN MINING IRON ORE.

| STATES AND TERRITORIES. | STEAM BOILERS. |  | Steam engines. | Animals. |
|---|---|---|---|---|
|  | Number. | Total horse power. |  |  |
| Total | 1,109 | 57,976 | 1,093 | 2,796 |
| Alabama | 46 | 1,971 | 40 | 283 |
| Colorado | 14 | 378 | 12 | 7 |
| Connecticut, Maine, and Massachusetts | 30 | 1,471 | 34 | 25 |
| Delaware and Maryland | 5 | 250 | 4 | 102 |
| Georgia and North Carolina | 25 | 885 | 25 | 235 |
| Idaho and Montana |  |  |  | 7 |
| Kentucky | 3 | 85 | 3 | 20 |
| Michigan | 332 | 24,180 | 387 | 368 |
| Minnesota | 33 | 1,610 | 30 | 42 |
| Missouri | 32 | 1,082 | 37 | 112 |
| New Jersey | 96 | 5,428 | 87 | 55 |
| New Mexico and Utah |  |  |  |  |
| New York | 134 | 6,839 | 89 | 163 |
| Ohio | 9 | 450 | 3 | 430 |
| Oregon and Washington | 4 | 300 | 6 | 5 |
| Pennsylvania | 220 | 7,414 | 210 | 498 |
| Tennessee | 29 | 855 | 22 | 130 |
| Texas |  |  |  | 19 |
| Virginia and West Virginia | 49 | 1,813 | 40 | 238 |
| Wisconsin | 48 | 2,965 | 64 | 57 |

## RÉSUMÉ.

The following table presents a résumé of the figures detailed in the preceding pages as far as comparisons can be made between the Tenth and Eleventh Censuses:

### COMPARISON OF THE TENTH AND ELEVENTH CENSUSES, WITH PERCENTAGES OF INCREASE.

| ITEMS. | 1889. | 1880. | Percentage of increase. |
|---|---|---|---|
| **PRODUCTION.** |  |  |  |
|  | *Long tons.* | *Long tons.* |  |
| Total | 14,518,041 | 7,120,362 | 103.89 |
| Red hematite | 9,056,288 | 2,243,993 | 303.58 |
| Magnetite | 2,506,415 | 2,134,276 | 17.44 |
| Brown hematite | 2,523,087 | 1,918,622 | 31.51 |
| Carbonate | 432,251 | 823,471 | *a*47.51 |
| **VALUE OF PRODUCT.** |  |  |  |
| Total value | $33,351,978.00 | $23,156,957.00 | 44.03 |
| Value per ton | 2.30 | 3.25 | *a*29.29 |
| **EMPLOYÉS.** |  |  |  |
| Number | *b*38,227 | *c*31,668 | 20.71 |
| **TOTAL WAGES.** |  |  |  |
| Amount paid as wages (*d*) | *b*$14,409,151 | *d*$9,538,117 | 51.07 |

| ITEMS. | 1889. | 1880. | Percentage of increase. |
|---|---|---|---|
| **WAGES PER ANNUM (OFFICE FORCE EXCLUDED).** |  |  |  |
| Wages per man (*e*) | *f*$409.95 | *c*$308.94 | 32.70 |
| **CAPITAL.** |  |  |  |
| Total | $109,766,199 | *c*$61,782,287 | 77.67 |
| Land | 78,474,881 | *c*48,274,149 | 62.56 |
| Buildings and fixtures | 7,673,520 | *c*8,657,375 | 81.57 |
| Tools and implements | 8,045,545 |  |  |
| Cash and stock on hand | 15,572,253 | *c*4,850,763 | 221.03 |
| **SUPPLIES, ETC.** |  |  |  |
| Supplies and materials | $4,998,988 | *c*$2,894,011 | 72.74 |
| Other expenditures | 3,795,509 | *g*1,020,429 | 271.95 |
| **POWER USED IN MINING.** |  |  |  |
| Number of boilers reported | 1,109 | *c*1,093 | 1.46 |
| Horse power of boilers | 57,976 | *c*28,422 | 103.98 |
| Steam engines | 1,093 | *c*821 | 33.13 |

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*a* Decrease.
*b* Including office force.
*c* In regular establishments.
*d* Not including amount paid to contractors.
*e* Excluding office force.
*f* Includes amount paid to contractors.
*g* This amount does not include taxes, insurance, etc.

## ILLUSTRATIONS OF IRON-ORE MINES.

The accompanying plates are introduced to represent some of the methods of exploiting for various kinds of iron ore, the illustrations being selected to show deposits in different states. As a rule, the larger mines are worked under ground, and it is difficult to secure satisfactory views of the occurrence of the ores or the methods pursued in winning them. As operations continue the appearances of the workings are constantly changing and the mines illustrated will present aspects somewhat different from those shown.

BROWN HEMATITE MINING AT NEW BIRMINGHAM, TEXAS.—The illustration shows the method employed in winning the bog ores of eastern Texas, where the deposits exhibit a regularity of occurrence unusual in brown hematite ore fields. When the hills are of sufficient elevation the ore appears with remarkable persistency as a nearly horizontal bed, outcropping along the sides and near the crests of the hills or "buttes" forming the rolling country of the neighborhood. The formation is of late geological age. A section would represent a soft sandstone, on which the ore lies, with a seam of clay generally between the ore and the stone. The ore is capped by a thin layer of ferruginous sandstone, while on top of this is surface sand. The ore is of the bog variety of brown hematite, varying in physical structure from compact masses to laminated and in some cases coarsely granular ore, and in color from light brown to nearly black. Occasionally glossy surfaces and incipient pots and boryoidal forms are found in the talus, resulting from the ledges breaking away. The physical characteristics are such as to indicate an ore which smelts readily, and this expectation is borne out by the operation of blast furnaces. The ore is won at low cost, the sand covering being removed by scrapers from a large area, and the bed of ore, 24 inches in thickness, with the cap rock, is then broken up by means of picks, the ore being roasted in piles and transported to the blast furnaces. These deposits are generally credited as remnants of the floor of a lake or lakes, channels made by subsequent erosion having formed the buttes or hills. The view is taken at New Birmingham, Cherokee county, Texas. A report on "The iron region of northern Louisiana and eastern Texas" was prepared for the House of Representatives.(*a*) The method of exploiting illustrated is also followed in mining the outcropping carbonates in portions of Ohio and Kentucky.

BROWN HEMATITE MINING NEAR ANNISTON, ALABAMA.—The occurrence of this class of ore in northeastern Alabama is generally in pockets, some of them of unusual magnitude. The one illustrated shows exploitations carried around masses of ocherous clays. The line of demarcation between the "cover" or stripping and the ore which underlies it can be distinctly seen. After the cover is removed and the ore taken out (which in the case illustrated is done with a steam shovel) the ore is conveyed to washers, then put on cars which haul the ore to the furnaces. Some of the large deposits of similar ores in Alabama and Tennessee have excellent equipments of handling and washing machinery which permit of producing ore at low cost.

MAGNETITE MINING AT CORNWALL, PENNSYLVANIA.—This plate illustrates a soft magnetite mine, representing the second working on the Big Hill of the Cornwall mines. The breadth of the ore deposit in Big Hill is about 400 feet. On 3 sides is an outcrop of trap, descending from the brow of the hill to water level. The ore mass rests against the sloping face of the trap dike, overlying and abutting against it. The function of this trap rock has been a preservative one, resisting erosion and preserving above water level a portion of the ore mass, which otherwise would have been swept away. The ore mass is a regular stratified formation, sloping southeastward against the edge of the mesozoic rocks of the South mountain and rising eastward into the air. Erosion has divided the deposit into 3 hills, separated by water courses, and bore holes indicate a saucer-shaped ore body below water level. This deposit is considered as having experienced two, and by some authorities three, stages of growth: first, a formation of pyritiferous lime shales, then a brown hematite formation, and finally a magnetite, retaining its original place and general stratification, but being reduced somewhat in bulk. The iron ore is removed by a system of terraces in advance of each other, on which railway tracks are laid and extended in as the ore is mined. The ore is broken down by rock drills and hand power and loaded into railroad cars. This deposit, of which the illustration represents one of a number of workings, supplied about one-half of the iron ore output of Pennsylvania in 1889, and its total output to that date exceeded 10,100,000 long tons. It is an instance of phenomenally cheap mining, as the entire work is carried on by "open cut", and the soft character of the ore requires but a small amount of explosive per ton. A full description of the deposit as it was in 1880 appears in the Tenth Census, volume XV, pages 223 to 229. Since 1880, 4,690,259 long tons have been taken from the Cornwall ore hills.

MAGNETITE MINING AT MINEVILLE, NEW YORK.—This plate is a view of the Old Bed 21 mine, representing an exploitation producing hard crystalline magnetite, which is there found in lenses of great size. It is broken down by means of rock drills, hauled to the surface by inclined skip roads, and discharged directly into railroad cars. The view is taken at a depth of 350 feet below the surface, looking toward the skip roads, and illustrates the enormous ore pillars which support the roof of the underground workings. The deposits of magnetite in the vicinity of Mineville have contributed, including 1889, over 9,500,000 long tons of iron ore.

The mines produce two distinct varieties of ore, one, known as Old Bed 21 ore, being a magnetite carrying apatite in such quantities as to raise the phosphorus beyond the bessemer limit, and the other being a magnetite carrying a siliceous gangue, but very low in phosphorus, known as New Bed ore. These general designations apply to ores obtained from various openings, the first portion of the commercial name Old Bed being derived from the original opening made in 1824, from which a large amount of ore has been won in workings extending 1,100 or 1,200 feet on the slope to a vertical depth of 300 feet. The No. 21 opening, which supplies the second portion of the commercial name for the ore, lies 200 feet south of the Old Bed opening, was started in 1829, and is one of the most impressive mines to view in the world. The massive pillars of ore supporting the roof (also of ore), capped with rock to within 50 feet of the surface, are exposed in the great open pit to a height of 300 feet,

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[a] Executive Document No. 195, Fiftieth Congress, first session.

MAGNETITE MINING AT MINEVILLE, NEW YORK. (See pages 22, 23.)

while the chambering extends much beyond the face and to a depth of about 350 feet vertically from the surface, the distance along the slope being 700 feet.

The openings producing New Bed ore cover a greater territorial area on account of being made upon a vein which is apparently continuous, but divided into two or three layers, while the various deposits of Old Bed ore seem to be a series of lenses lying in echelon or in nearly parallel veins of varying thickness and dip. The present shipments of New Bed pure ore, made up from daily analyses, show iron 66 and phosphorus 0.025 per cent, and New Bed lean ore carries about 55 per cent of iron, with phosphorus inside of the bessemer limit. The Old Bed 21 ore yields iron 66.18 and phosphorus 0.5 to 2.5 per cent.

Occasional horses of rock cut the Old Bed lenses, while the New Bed has a series of faults of pyritiferous material, but sulphur is not found in the ore. On the other hand, pockets of ore approaching chemical purity are met with. From one of these over 40,000 tons of ore were won during 1889, which averaged 68.6 per cent of iron and 0.033 phosphorus. One-third of all the analyses of ore from this pocket showed 70 per cent or over of iron.

RED HEMATITE MINING AT IRON MOUNTAIN, MISSOURI.—The dip of the ore is shown quite plainly. On the left is the porphyry "foot wall" sloping down under the ore; on the right the "hanging wall" of limestone and sandstone, the ore being found between the hanging and foot walls. The photograph is a part of the celebrated Iron mountain, where the ore is broken down, loaded into tram cars, several of which are seen in the illustration, hauled up the shafts, and discharged into railroad cars or on dump piles. Originally the Iron mountain deposit was worked by removing a capping of ore, and subsequently a considerable open cut was made. Lately much of the ore has been taken from the underground workings, the chief source of supply being a talus covering the original hillside, which was subsequently covered by later deposits. At Iron mountain lower grades of ore, after being mined, and some of the older dump piles, are hydraulicked and jigged. Professor Potter says the mountain is composed of red, brown, with some bluish porphyry, all more or less distinctly bedded, and the beds dip away on all sides with the surface slopes, thus exhibiting a rude, yet well marked, dome-like structure. The same dome form appears in the main ore vein, the top of which was originally exposed for an acre or more at the summit of the hill. Cutting through this in the subsequent working, the vein was found to dip away on all sides with the surface slopes, but at a steeper angle, following to some extent the bedding of the porphyry, yet inclining more rapidly. In removing this dome an open cut was carried down 130 feet below the original top of the hill, and the marginal vein forming an irregular ellipse 1,000 by 500 feet, as well as the interlacing veins within this ellipse, were exploited.

One of the most interesting features of the Iron mountain deposit is what is locally known as the "old surface ore", described by Professor Potter in 1884 as follows:

> Over the whole western side of the original hill, and dipping away with increasing thickness, may be seen a very ancient hill of surface ore, composed of irregular and partly rounded fragments of black, somewhat decomposed, ore. This passes beneath the overlapping sandstone and limestone below, forming in the lower bed of the latter a remarkable ore conglomerate with limestone cement. It will undoubtedly be found stretching away down the ancient hillside to where the latter runs into the bottom of the valley below the silurian beds. The quantity of ore stored up in this interesting period must be very large indeed, judging from the developments already made, and the great area over which it is found, outcropping well upon the sides of the hill and following down the slope, always with increasing thickness beneath the covering of hardened clays and shales. Comparatively little clay or foreign matter, and no hard rock at all, occurs with the fragments of rich black ore.

RED HEMATITE MINING, TOWER, MINNESOTA.—The plate shows a hard red hematite mine at Soudan, near Tower, Minnesota, where the iron ore is interbedded with jasper in folded and crumpled beds that occur in what is locally called the Keewatin formation. The lenses of ore now being worked appear to lie in echelon between nearly vertical walls, the foot wall being a slate and the hanging wall banded jasper and "soap rock". Both are well illustrated in the cut. The ore lenses exploited are found on two nearly parallel hills, but the ore has also been found by drilling between these ridges. Where ore outcropped or was found close to the surface of the ground it was exploited by large open cuts. At present, however, most of the ore is won by underground workings carried below the floors of these open exploitations. The ore, which is hard and dense, carries high percentages of iron and but small amounts of deleterious ingredients. It constitutes a large proportion of the charge used at the blast furnaces in Illinois, and is also shipped to blast furnaces near the Atlantic seaboard, the purity of the ore permitting it to stand long transportation. From the iron-ore mine openings near Tower about 2,000,000 long tons of ore have been won since their opening in 1884. A monograph upon the iron ores of Minnesota, published by the State Geological and Natural History Survey, presents illustrations of other workings on the Vermilion range.

## IMPORTATIONS OF IRON ORE INTO THE UNITED STATES.

Reference has been made as to the quantity of foreign iron ore used, and an investigation of this subject is properly associated with a discussion of domestic iron ore production.

The importations of iron ore into the United States during the calendar year 1889 have been supplied by Major S. G. Brock, chief of the bureau of statistics of the Treasury department. The total amount received during the calendar year 1889 was 853,573 long tons, valued at $1,852,392. This ore was shipped from the following countries, contributing in the order named:

### IMPORTS OF IRON ORE IN 1889, BY COUNTRIES.

[Long tons.]

| COUNTRIES. | Quantity. | Value. |
|---|---|---|
| Total | 853,573 | $1,852,392 |
| Spain | 298,568 | 621,481 |
| Cuba | 243,255 | 535,524 |
| French Africa | 97,583 | 180,697 |
| Italy | 87,410 | 228,164 |
| England | 54,496 | 111,638 |
| Greece | 23,955 | 32,880 |
| Newfoundland and Labrador | 14,450 | 43,100 |
| British Columbia | 13,670 | 27,860 |
| Portugal | 6,659 | 15,151 |
| France | 6,565 | 17,911 |
| Quebec, Ontario, Manitoba, and Northwest territory | 4,091 | 10,697 |
| Turkey in Asia | 2,870 | 27,265 |
| Germany | 1 | 24 |

### SUMMARIZED IMPORTS OF IRON ORES.

[Long tons.]

| COUNTRIES. | Quantity. | Value. |
|---|---|---|
| Total | 853,573 | $1,852,392 |
| British possessions in North America | 32,211 | 81,657 |
| Cuba | 243,255 | 535,524 |
| Europe | 477,654 | 1,027,249 |
| Asia | 2,870 | 27,265 |
| Africa | 97,583 | 180,697 |

The bureau of statistics has no data to demonstrate that the ore was mined in the country from which shipment was made; but little, if any, of it should be credited to other territory than above noted.

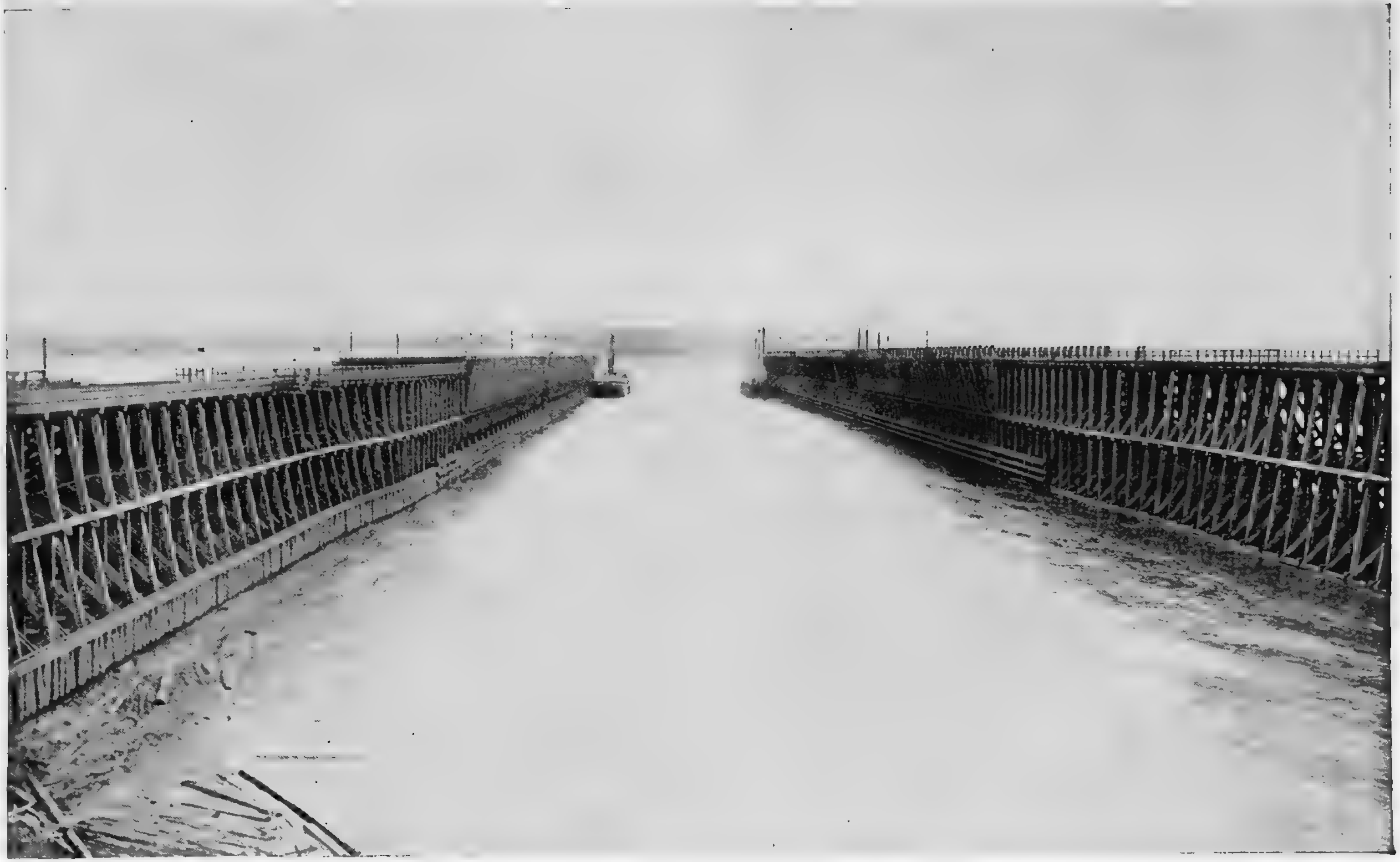
The foreign iron ore was received at the following ports, named in the order of their prominence:

### IMPORTS OF IRON ORE, BY PORTS OF ENTRY.

[Long tons.]

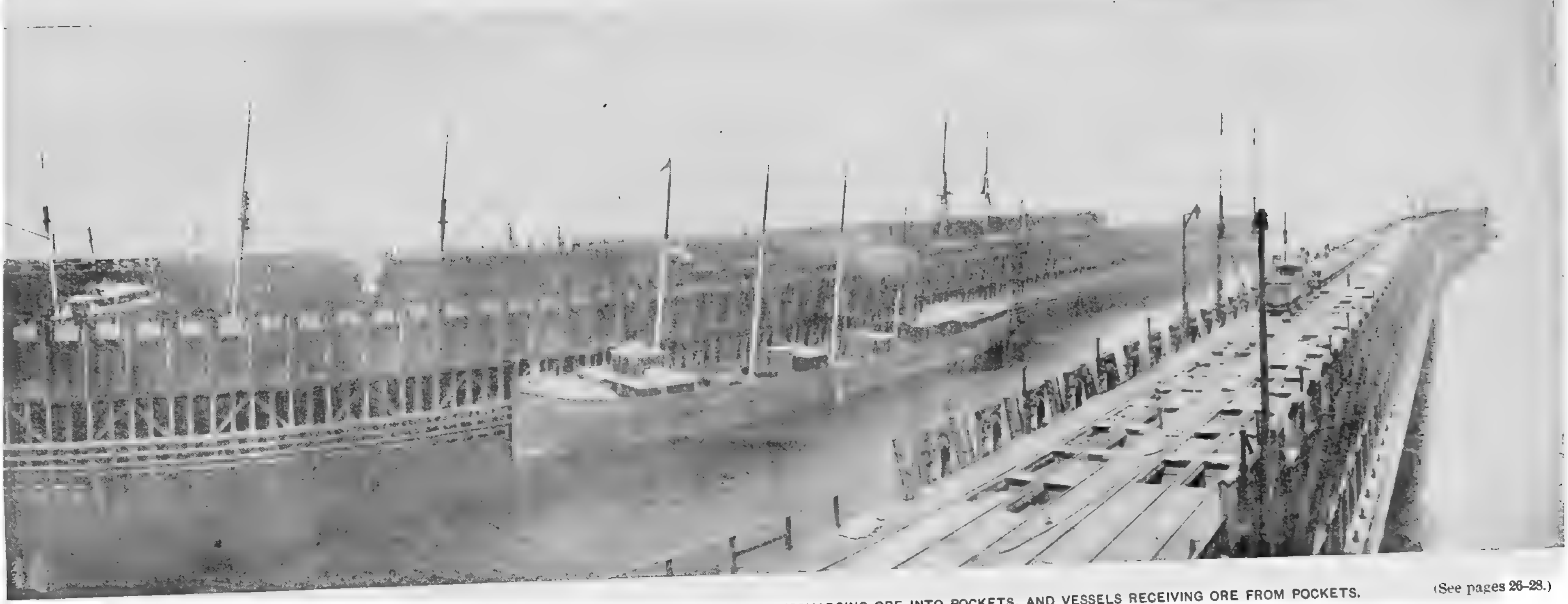
| PORTS. | Quantity. | Value. |
|---|---|---|
| Total | 853,573 | $1,852,392 |
| Philadelphia, Pennsylvania | 525,124 | 1,192,141 |
| Baltimore, Maryland | 273,050 | 519,736 |
| New York, New York | 25,824 | 72,297 |
| Puget Sound, Washington | 13,670 | 27,860 |
| Perth Amboy, New Jersey (*a*) | 11,558 | 26,075 |
| Oswego, New York | 2,309 | 6,353 |
| Cuyahoga, Ohio | 1,224 | 3,403 |
| Vermont district | 462 | 707 |
| Pensacola, Florida | 135 | 608 |
| Buffalo, New York | 78 | 198 |
| San Francisco, California | 61 | 2,525 |
| Boston, Massachusetts | 50 | 283 |
| Detroit, Michigan | 18 | 36 |
| Chicago, Illinois | 5 | 58 |
| Pittsburg, Pennsylvania | 4 | 88 |
| Saint Louis, Missouri | 1 | 24 |

*a* This port may also be classed under the head of ports of New York harbor.



GENERAL VIEW OF ORE SHIPPING DOCKS AT ASHLAND, WISCONSIN.

(See pages 27, 28.)



(See pages 26–28.)

GENERAL VIEW OF ORE SHIPPING DOCKS, ESCANABA, MICHIGAN, SHOWING TRAINS OF CARS DISCHARGING ORE INTO POCKETS, AND VESSELS RECEIVING ORE FROM POCKETS.

Grouping these ports, it is found that the receipts were as follows:

RECEIPTS OF FOREIGN IRON ORE, BY GROUPS OF PORTS.

[Long tons.]

| PORTS. | Quantity. | Value. |
|---|---|---|
| Total | 853, 573 | $1, 852, 392 |
| Atlantic | 835, 741 | 1, 811, 140 |
| Lake | 3, 634 | 10, 048 |
| Pacific | 13, 731 | 30, 385 |
| Miscellaneous | 467 | 819 |

The high values attached to some of the smaller quantities shipped from a certain country or received at a specific port represent the importation of ores adapted for particular uses, owing to having in combination other minerals than iron.

The following statement, from information furnished by Mr. James M. Swank and others, showing the production of iron ore in such countries as furnished statistics, is given for purposes of comparison:

PRODUCTION OF IRON ORE IN THE YEAR 1889, BY VARIOUS COUNTRIES

|  | TONS. |  | TONS. |
|---|---|---|---|
| Great Britain | 14, 546, 105 | Sweden | 985, 904 |
| United States | 14, 518, 041 | Algeria (*a*) | 475, 000 |
| Germany and Luxemburg | 11, 002, 187 | Cuba | 256, 278 |
| Spain (shipments from) | 5, 067, 144 | Belgium | 202, 431 |
| France (*a*) | 2, 500, 000 | Italy | 173, 489 |
| Austria-Hungary (*a*) | 2, 300, 000 | Canada | 75, 162 |
| Russia (*a*) | 1, 500, 000 |  |  |

*a* Estimated.

The figures given above for Great Britain, the United States, Cuba, and Canada are tons of 2,240 pounds, and for the remaining countries the metric ton of 2,204 pounds.

## COMMERCIAL VALUE OF IRON ORE.

The success of any iron-producing enterprise is largely contingent upon the character of the materials which are accessible. Until within a few years the fuel used attracted a large share of attention, and a blast furnace manager or proprietor gave less care to the ore used than to the fuel with which this ore was to be smelted. As, however, the amount of metallic iron and other constituents of an ore, and to a large extent the physical conditions of the ore, influence the smelting and affect the fuel consumption per ton of pig iron made, the subject of a proper ore supply for iron works has gradually won more attention from those who produce pig iron, and the policy of selling and purchasing iron ores on a unit basis is becoming more prevalent. This unit basis is a system for determining the value of an ore by the number of units of iron it contains in each 100 component parts, the price per unit being affected by the presence of other constituents than iron, and also by the number of units of iron in the ore; that is, an ore carrying 60 per cent or over of iron would command a higher price per unit than ore carrying 30 per cent or less, because a smaller amount of fuel and flux would be necessary under similar conditions to smelt a given quantity of it. Again, the unit price would be influenced by the amount of phosphorus or other materials in the ore, for if the phosphorus is greater than one part in 1,000 of iron the unit price would be considerably less than where the phosphorus was below this proportion.

In determining the value of different ores a number of factors must be considered. First, the amount of iron in the ore naturally attracts attention, and, the conditions being otherwise the same, a rich ore will require less fuel to smelt it, and therefore less cost for fuel than a leaner ore. Under ordinary circumstances a richer ore will also have less material to be fluxed out, and a smaller amount of limestone will be necessary for fluxing than where the iron is displaced by other constituents. The smaller amount of flux required further reduces the quantity of cinder made and the expense of providing room for this cinder and means for handling it.

Another important consideration is, that richer ores, requiring less fuel and flux, occupy less space in the blast furnace than the materials required in treating the lean ores, and generally permit of more rapid driving. Therefore rich ores will demand a smaller outlay in the cost per ton of product, for interest on the plant, management, and other fixed charges are divided by a greater tonnage than would be the case where lean ores are used. There is thus good reason for the price per unit being higher with rich ores than with lean ores. The unit basis was largely established by the importers of foreign iron ores, but it has been adopted to a limited extent by miners of domestic ores, and this method is gaining in favor.

Many of the iron ores of the country are sold under general market quotations by the long ton from calculations made on the unit basis, and each year finds the consumers and producers estimating iron ores more at the intrinsic value of the product of individual mines rather than on a general basis, although, of course, it is essential that some market standard should be established for any ore and for any district.

In buying and selling ores on the unit basis the most approved practice is to analyze the ore dried at or above 212° fahrenheit, so as to determine the amount of iron which the ore yields in the blast furnace; but this system has been objected to, because water is a practical constituent in ores until after the material is fed to blast furnaces, and as such is subject to all costs of freight, handling, etc. The hygroscopic moisture in magnetites seldom exceeds 2 per cent; it reaches 5 per cent in some red hematites, and often 15 per cent in brown hematites.

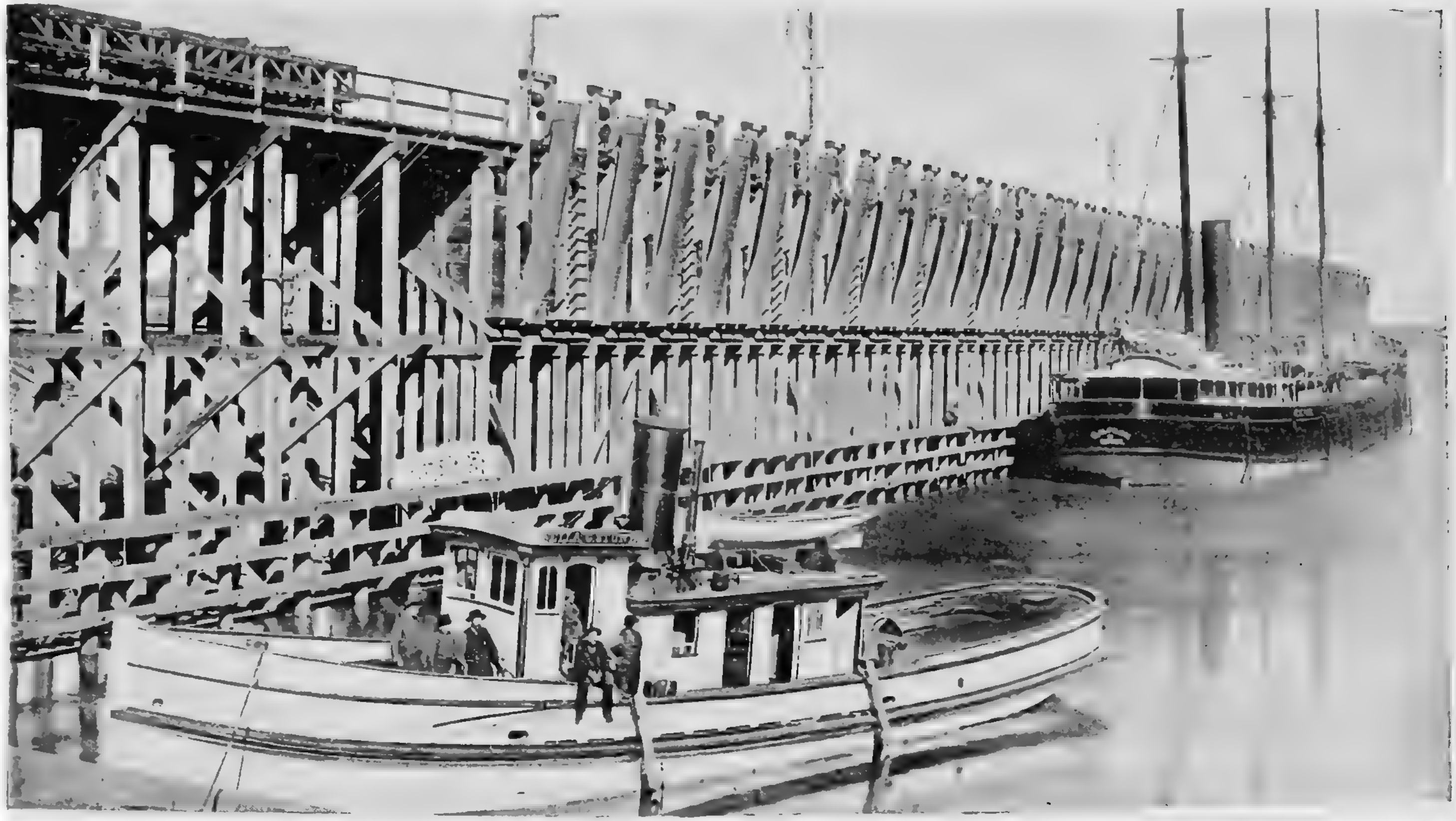
## TRANSPORTATION AND HANDLING IRON ORES.

Probably in no country has the transportation of iron ore assumed such proportions as in the United States. A number of the European countries, and also the United States, have imported large quantities of iron ores from Spain, Italy, Greece, and Africa, but, taking into consideration the distance covered and the relative location of the domestic iron mines and blast furnaces, it is probable that in no other part of the world has so great an amount of iron ore been transported over such long distances, requiring so many handlings. The Lake Superior district is the most important contributor to this tonnage, having in the year 1889 shipped 7,390,387 long tons, and since its first opening, in 1853, furnished nearly 48,500,000 tons to the country's supply. Most of this ore has been, and now is, handled by lake vessels, but all-rail transportation has been growing in importance, not sufficiently, however, to materially affect the amount of ores sent forward by water. In each of the 4 districts forming the Lake Superior region the iron-ore mines are located at a distance from the lakes. In the Marquette range the nearest mines are 12 miles from a shipping port; in the Menominee range none of the mines are less than 41 miles from a shipping port. The center of the Gogebic range is 39 miles, and the Tower mines, in the Vermilion range of Minnesota, are 69 miles from a shipping point, while the mines at Ely are 26 miles farther removed. Not more than 30 per cent of the Lake Superior iron ore brought by vessels to lower lake receiving ports is consumed at these ports, but most of it is shipped by railroad to furnaces located from 60 to 475 miles from them.

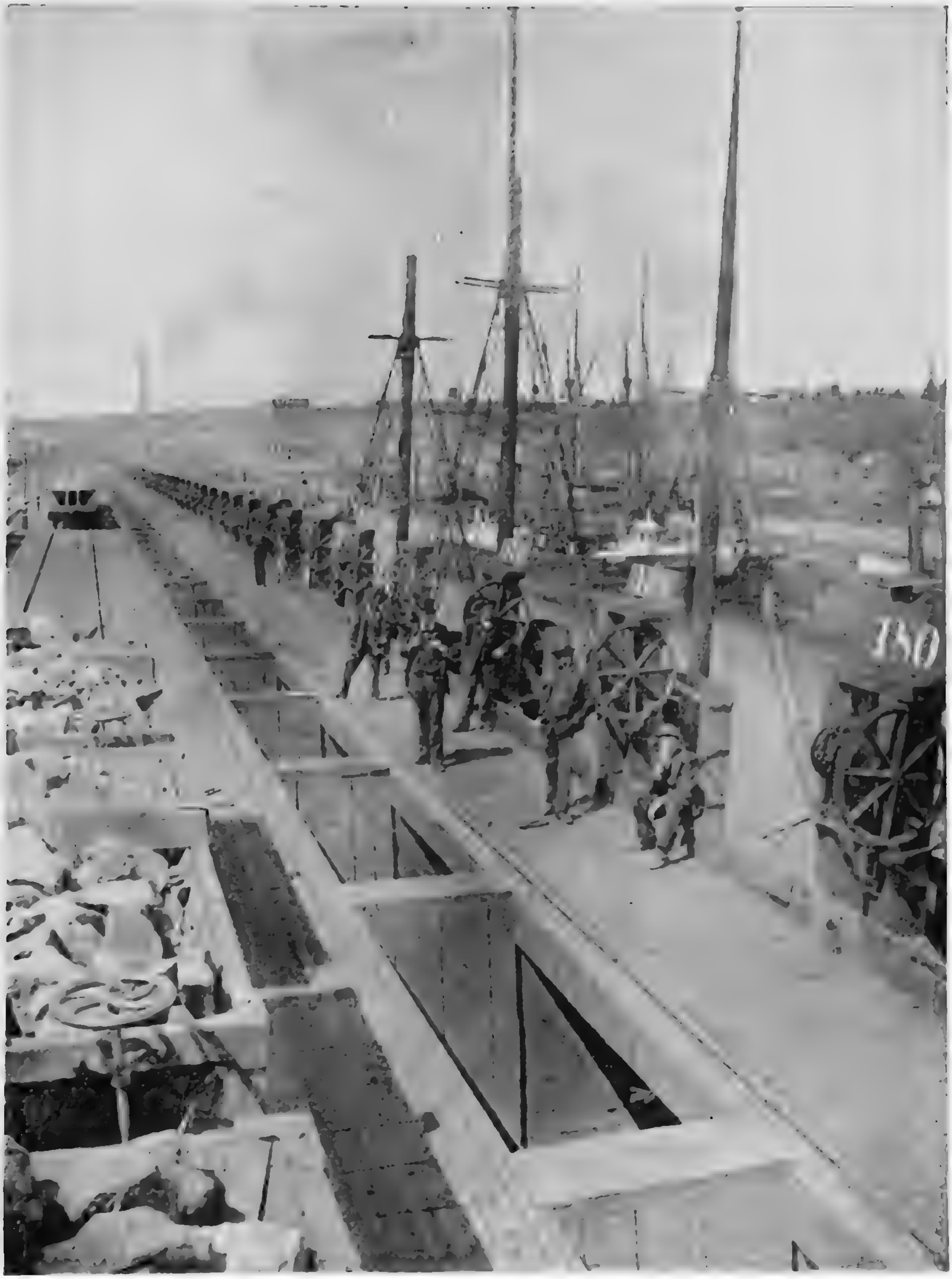
The ore from Lake Superior mines is consumed by furnaces as far east as Troy, New York, eastern New Jersey, and southeastern Pennsylvania, and forms the bulk of the ore used in Allegheny county, Pennsylvania (the largest pig-iron producing center of the United States), as well as for furnaces in central Pennsylvania, in the Shenango valley in western Pennsylvania, in the Mahoning valley in eastern Ohio, and in the Wheeling district of West Virginia and southern Ohio. Chicago, the second largest pig-iron producing center, and Joliet, Illinois, are solely dependent on Lake Superior ores. In a number of instances Lake Superior ores in their routes to points of consumption cross ores shipped from other mining centers to other points of iron production. Thus, in reaching Troy, New York, the Lake Superior iron ores cross in transit ores from the Lake Champlain district and other northern New York points going south into Pennsylvania; and in gaining access to some of the points on the Ohio river the Lake Superior ores pass Missouri ores bound up the Ohio to furnaces farther east. They also form an important factor of the charge of blast furnaces in districts which produce large quantities of local ores, and in some of these, as in the Shenango district of Pennsylvania and the Mahoning district of Ohio, they practically displace the leaner local ores. In others, as in the Hocking region of southern Ohio, Lake Superior ores are used to enrich the ore mixture to a point which permits of furnaces being operated successfully, which could not otherwise run on the relatively inferior ores which abound in that section. The readiness with which the majority of these Lake Superior ores smelt also encourages their use in furnaces in New Jersey and eastern Pennsylvania which are conveniently located for a supply of the more refractory magnetites or which command large quantities of lean brown hematite ores.

To obtain facilities for cheaply handling Lake Superior ores the railroads which penetrate the various districts have constructed expensive terminal facilities, consisting of one or more shipping docks, with the railroad tracks elevated from 35 to 47.5 feet above the water level, and with pockets, into which the ore from the cars is dumped by means of drop bottoms. From these pockets the ore is discharged by iron chutes, let down into the vessel's hold. In this manner the ore is never handled from the time it leaves the mine until it is shoveled into buckets when the vessel is discharged at lower lake ports, and no manual labor is necessary other than poking the ore with poles from the cars into the bin and from the bin into the chutes, and in some cases but little of this is required.

The shipping ports for the Lake Superior iron-ore district are 6, and from these 6,810,108 long tons were sent forward by water transportation in the year 1889. The most important port is Escanaba, Michigan, on Lake Michigan, from which 3,003,632 long tons were shipped in 1889, this amount being 44.11 per cent of the total shipments by vessel of Lake Superior ores during the year. The supply of ore for the Escanaba docks, 4 in number, came from the Menominee, the Marquette, and the Gogebic districts. All of the Menominee ore which required lake transportation (1,684,618 tons), 40.4 per cent of the ore from the Marquette range loaded into vessels (1,021,006 tons), and 16.7 per cent of the shipments from the Gogebic range (298,008 tons) were handled by these docks. The docks at Escanaba are operated by the Chicago and Northwestern Railway Company, and represent an aggregate length of 4,898 feet, the shortest being 1,082 feet long and the longest 1,500 feet. These docks have double tracks and an



SIDE VIEW OF ORE SHIPPING DOCK AT TWO HARBORS, MINNESOTA, SHOWING HINGED CHUTES AND A VESSEL IN POSITION TO RECEIVE ORE.
(See pages 27, 28.)



TOP VIEW OF AN ORE SHIPPING DOCK AT MARQUETTE, MICHIGAN, SHOWING THE WINCHES FOR HANDLING HINGED CHUTES, THE TOP OF THE BINS, AND LOADED CARS READY TO BE DISCHARGED. (See page 27.)

aggregate of 828 pockets, which contain a total of 95,500 tons. The outlay required for their construction and equipment was about $1,000,000.

Ashland, Wisconsin, on Lake Superior, ranked second in 1889 as a shipper of iron ore, 1,484,802 tons, or 21.80 per cent of the total lake shipments of the Lake Superior district, having been hauled to the 3 docks at this point. This ore was from the Gogebic range, and the amount handled at Ashland and that passing through the docks at Escanaba represent the total shipments by water from the Gogebic range in 1889 (1,782,810 tons). 2 of the docks at Ashland are operated by the Milwaukee, Lake Shore and Western Railroad Company, and 1 by the Wisconsin Central Railroad Company. They were constructed at a total cost of $739,000. The docks are 1,404 feet long, making the aggregate 4,212 feet. They each have 234 pockets, giving a total of 702 for the 3, the aggregate capacity being 78,250 tons. 2 of the docks accommodate 3 tracks, and 1 of them 4 tracks.

Following close upon Ashland is Marquette, Michigan, on Lake Superior, which in 1889 shipped 1,376,335 tons, being 20.21 per cent of the total lake shipments of the entire district for that year. This ore was all from the Marquette district, and represented 54.6 per cent of the ore forwarded by the lakes from the Marquette range. Additional facilities lately added give promise of Marquette recovering her position as a shipping point for iron ores. It has 4 ore docks, operated by the Duluth, South Shore and Atlantic Railway Company. They vary in length from 600 to 1,600 feet, the aggregate being 4,900 feet. The total number of pockets in the 4 docks is 798, and the total capacity is 74,000 tons. 3 of the docks accommodate 3 tracks, and 1 has 4 tracks.

A comparatively small amount of ore from the Marquette range was handled at the ports of Saint Ignace and Gladstone, Michigan, on Lake Michigan, the former shipping 51,853 and the latter 73,847 tons, being 2.1 and 2.9 per cent, respectively, of the lake shipments from the Marquette range and 0.76 and 1.08 per cent of the total lake shipments of iron ore. The dock at Saint Ignace is 800 feet long, and is operated by the Duluth, South Shore and Atlantic Railway Company. It has 100 pockets, with an aggregate capacity of 10,000 tons, and supports 3 railroad tracks. There is also an ore dock at L'Anse, Michigan, on Lake Superior, which was not used during 1889. This dock is 1,000 feet long, has 100 pockets, and an aggregate capacity of 8,000 tons. It was formerly used for some of the shipments from the Marquette range.

The ore from the Vermilion range in Minnesota is transferred from cars to vessels at Two Harbors, Minnesota, on Lake Superior. The Duluth and Iron Range railroad has 2 docks here, each 1,056 feet long, making an aggregate of 2,112 feet. They accommodate double tracks, and have a total of 303 pockets, the aggregate capacity being 40,000 tons. $800,000 was expended in constructing these docks. The amount of ore handled at Two Harbors during the year 1889 was 819,639 tons, all of which came from Minnesota, and represented 12.04 per cent of the total lake shipments from the Lake Superior region.

The accompanying plates illustrate the construction, arrangement, and equipment of ore shipping docks at Escanaba and Marquette (Michigan), and Two Harbors (Minnesota). The heights, lengths, number of pockets, capacity in long tons, and number of tracks of each of the docks are detailed below. The plates exhibit views of the tops of the docks, and show openings to the ore pockets, some of which are filled with ore. On the tracks which pass over these pockets locomotives and trains of cars are seen. The drop-bottom cars discharge into the pockets, the sides of which slope toward the water front of the dock, gradually contracting toward the bottom, where the openings are closed by doors. When vessels to be loaded are made fast to the sides of the docks and hatches removed the semicircular iron chutes are let down into each hatchway by means of winches and chains, and when the doors of the pockets are opened the ore is discharged by gravity into the hold of the vessel. The semicircular chutes are exhibited as in position for discharging the ore from the pockets. These semicircular chutes are seen extending above the top of the first dock, and one is being lowered from the second dock. The presence of numerous vessels at, and of trains of ore cars on, each dock is a representation of daily operation during the shipping season. Other ore-shipping docks are similar to those illustrated, but each possesses some peculiarity of construction or detail.

## SHIPPING DOCKS.

The following is a list of shipping docks specially constructed for handling iron ore from the Lake Superior region, together with their capacity, etc:

The Duluth, South Shore and Atlantic Railway Company at Marquette, Michigan, has 4 docks, and 2 others at L'Anse and Saint Ignace, Michigan, of the following description:

No. 1.—Height of dock above water, 42 feet; length of dock, 1,300 feet; number of pockets, 220; number of tracks, 3; capacity, 15,000 long tons.

No. 2.—Height of dock above water, 35 feet; length of dock, 600 feet; number of pockets, 78; number of tracks, 3; capacity, 4,000 long tons.

No. 3.—Height of dock above water, 44 feet; length of dock, 1,600 feet; number of pockets, 300; number of tracks, 3; capacity, 25,000 long tons.

No. 4.—Height of dock above water, 47.5 feet; length of dock, 1,400 feet; number of pockets, 200; number of tracks, 4; capacity, 30,000 long tons.

The ore dock at L'Anse, Lake Superior, Michigan, is described as follows:

Height of dock above water, 38 feet; length of dock, 1,000 feet; number of pockets, 100; capacity, 8,000 long tons.

The ore dock at Saint Ignace, Michigan, is described as follows:

Height of dock above water, 42 feet; length of dock, 800 feet; number of pockets, 100; number of tracks, 3; capacity, 10,000 long tons.

The cars built especially for ore trade by this company include 3,200 hopper-bottom 8-ton capacity cars and 600 hopper-bottom 20-ton capacity cars.

At Escanaba, Michigan, the Chicago and Northwestern Railway Company has 4 double ore docks, as follows:

No. 1.—Height of dock, 46 feet; length of dock, 1,104 feet; number of pockets, 184; number of tracks, 2; capacity, 23,000 long tons.
No. 2.—Height of dock, 39 feet; length of dock, 1,082 feet; number of pockets, 192; number of tracks, 2; capacity, 19,300 long tons.
No. 3.—Height of dock, 39 feet; length of dock, 1,212 feet; number of pockets, 202; number of tracks, 2; capacity, 20,000 long tons.
No. 4.—Height of dock, 46 feet; length of dock, 1,500 feet; number of pockets, 250; number of tracks, 2; capacity, 33,200 long tons.

The cost of the 4 ore docks at Escanaba was $922,000; cost of cars, $1,368,000; a total of $2,290,000. The company uses in the distribution of the ore 3,300 small cars of from 7 to 10 tons capacity and 1,800 large cars of 20 tons capacity.

At Two Harbors, Minnesota, the Duluth and Iron Range Railroad Company has 2 double ore docks, as follows:

No. 1.—Height of dock, 47 feet; length of dock, 1,056 feet; number of pockets, 162; number of tracks, 2.
No. 2.—Height of dock, 46 feet; length of dock, 1,056 feet; number of pockets, 141; number of tracks, 2.

The capacity of both ore docks is 40,000 long tons. The cost or value of the 2 docks is $800,000, and the value of the 750 cars is $431,250, a total of $1,231,250. The company has 750 double-hopper 8-wheel ore cars, having a capacity of 50,000 pounds each.

At Ashland, Wisconsin, the Wisconsin Central Railroad Company and the Milwaukee, Lake Shore and Western Railroad Company have iron-ore docks.

The Milwaukee, Lake Shore and Western Railroad Company has 2 docks, as follows:

No. 1.—Height of dock, 40 feet; length of dock, 1,404 feet; number of pockets, 234; number of tracks, 4; capacity, 23,000 long tons.
No. 2.—Height of dock, 45 feet; length of dock, 1,404 feet; number of pockets, 234; number of tracks, 3; capacity, 27,000 long tons.

The 2 ore docks are valued at $483,000, and the 850 cars at $330,000, a total of $813,000. Of the cars, 800 have a capacity of 45,000 pounds and 50 a capacity of 60,000 pounds each.

The Wisconsin Central Railroad Company has 1 double ore dock, as follows:

Height of dock, 46 feet; length of dock, 1,404 feet; number of pockets, 234; number of tracks, 3; capacity, 28,250 long tons.

The dock cost $256,000, and the cars $388,800, a total of $644,800. Of the cars, 789 have a capacity of 50,000 pounds each, and 90 drop-bottom gondola cars have each 40,000 pounds capacity.

Among the iron-mining companies which have a considerable investment in vessels used in the transportation of iron ore are the Republic Iron Company, the Minnesota Iron Company, the Cleveland Iron Mining Company, the Lake Superior Iron Company, and the Chapin Mining Company.

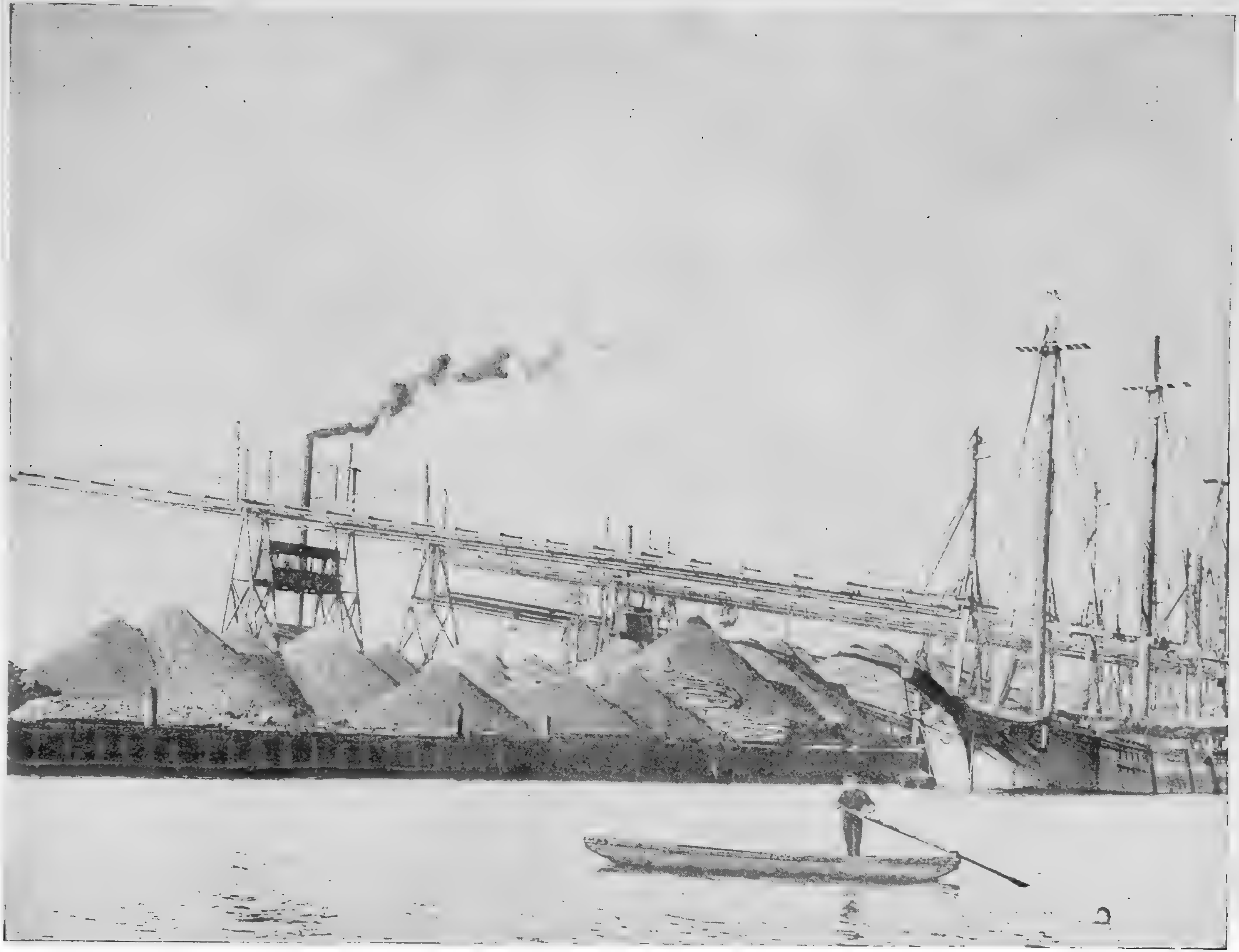
The description, size, and cost of the docks above mentioned could be supplemented by a number of others, which, however, would not equal the capacity or the outlay required in those given. The mines which produced magnetite in the vicinity of Lake Champlain transport a considerable portion of their output each year by canal, the ore being brought to the lake by cars and then loaded from docks into boats. In addition, as the locations of the mines are upon either individual or narrow-gauge railroads, the companies' cars are not taken beyond their own road and transfer chutes are erected to facilitate loading into trunk line cars.

As instances of the location of additional shipping docks, the following may be mentioned: Plattsburg, Port Henry, and Crown Point, on Lake Champlain; Burden and Fort Montgomery, on the Hudson river, and below Saint Louis, on the Mississippi river.

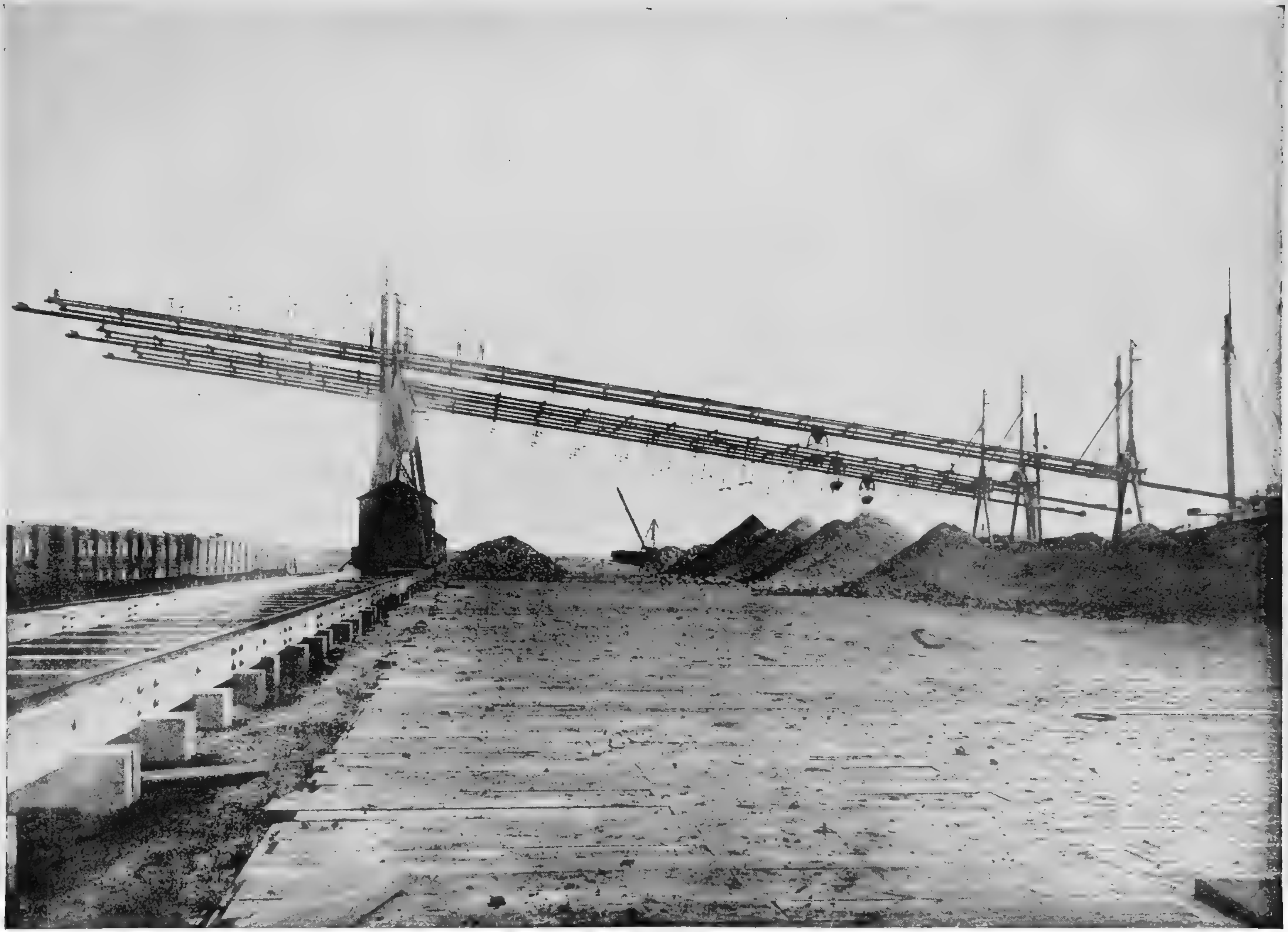
The total investment for docks especially built and equipped for handling and shipping iron ore approximated $4,000,000 in the year 1889.

## RECEIVING DOCKS.

The subject of ore transportation would be incomplete unless, in addition to the ore-shipping docks, mention was made of the ore-receiving docks, which have been especially constructed for the purpose of handling the ore to blast furnaces or at points from which railroads radiate to blast furnaces. The blast furnaces at Milwaukee (Wisconsin), Chicago (Illinois), Detroit (Michigan), Cleveland (Ohio), Tonawanda (New York), as well as those along the shore of Lake Michigan, have docks more or less extensive and equipped with steam handling machinery for the removal of ore from the holds of vessels which bring the ore from the shipping docks on Lakes Michigan and Superior. There are also docks owned by railroad companies or by corporations located on Lake Erie at Toledo, Sandusky, Huron, Lorain, Cleveland, Fairport, and Ashtabula (Ohio), at Erie (Pennsylvania), and at Buffalo (New York). Cleveland has 4 such docks, Buffalo 3, Ashtabula and Fairport 2 each, the balance of the points named having 1 ore dock each. The largest of these ore docks at Fairport, Ohio, has a frontage 1 mile in length, with room for stocking ore extending back 180 to 350 feet in width. The 2 docks at Cleveland are one-half mile in length, with a storage capacity 350 feet wide. The capacity of the 3 docks named will reach from 1,000,000 to 1,500,000 long tons



RECEIVING DOCK FOR IRON ORE, CLEVELAND, OHIO, SHOWING WATER FRONT, VARIOUS ORES STACKED IN PILES, AND BRIDGE TRAMWAY CONVEYING APPARATUS. (See pages 28, 29.)



FLOOR OF AN ORE RECEIVING DOCK, CLEVELAND, OHIO, WITH BRIDGE TRAMWAY CONVEYING APPARATUS IN POSITION, ORE ON DOCK, RAILWAY AND CARS IN POSITION FOR LOADING, AND THE TRAVERSING TRACKS ON WHICH BRIDGE TRAMWAYS MOVE LENGTHWAYS ON THE DOCK. (See pages 28, 29.)

each, as the ore is stored from 25 to 50 feet in height; but owing to the necessity of keeping the various kinds of ore and that from different mines separate and the constant demand for ore, the docks never carry their maximum capacity. About one-third of the ore as it is received is handled directly from the vessels bringing it from the upper lakes into railroad cars during the 7 months of the shipping season, and about two-thirds are placed in stock on docks, from which regular shipments of ore are continuously made, but toward the close of the shipping season there is usually a large accumulation on docks for shipment during the winter to blast furnaces. The storage capacity of these receiving docks varies from 300 to 500 tons per front foot of dock, and the machinery employed in those of new construction is such as to remove the weight of ore from the dock front to insure stability, and in many cases the steam machinery which takes the ore from the hold of the vessel to the stock pile is also used to convey it from stock piles to railroad cars.

Mr. Alexander E. Brown, of Cleveland, Ohio, who has made a specialty of equipping docks and handling large quantities of iron ore, states that the ore from the Lake Superior region, when loaded into cars, occupies from 10 to 16 cubic feet per long ton, the average approximating 14 cubic feet. If, however, these ores are piled in large quantities on docks, the space occupied varies from 10 to 13 cubic feet per long ton of ore. In handling this ore in buckets, where it is loosely placed, the volume is somewhat greater, the average per long ton determined by a number of experiments being 13.625 cubic feet for Marquette and 15.2 cubic feet for the Gogebic and Menominee ores.

The machinery equipment of the various docks differs greatly, but 5 general types may be mentioned: (1) swing-boom derricks, operated either with engines placed on them or driven by wire rope from engines at a distance; the mast being either stationary or carried on trolleys, the iron buckets are lowered into the holds of vessels, where the navvies shovel the ore into them, the steam machinery raising the buckets and swinging the boom to the point where the ore is to be deposited; (2) a similar arrangement of swing-boom derricks, discharging into hoppers and from these into tram cars, which carry the ore from the ore dock to stock piles, located at a considerable distance from the water; (3) an A frame which lifts with the buckets and discharges them into tram cars that run to the stock pile or dump into pockets and thence into cars; (4) aprons which project over the holds of vessels; the buckets traveling up the incline of this apparatus are dumped into tram cars, which run by gravity, discharge, and return automatically; (5) booms or aprons upon which the buckets are carried and continue their journey either over cables or on trussed bridges, the buckets dumping automatically at the point desired and returning to the hold without detaching from the machinery.

These dock equipments have been put up at great expense, some of the docks costing equipped over $800,000, and by them it has been possible to handle quantities of ore which could not be moved in any other way, while the cost of such handling has been reduced to a minimum. The expense of shoveling the ore into buckets in the holds of vessels varies from 10 to 15 cents per long ton, the rate being controlled by stevedores, while with the improved apparatus at some of the docks this ore in buckets is lifted from the vessel, carried back 350 feet and dumped, at a total cost, including labor, wear and tear, interest, and fuel account reported, of from 1 to 1.5 cents per ton. With 21 men in the hold of a vessel carrying 2,000 long tons of iron ore the entire cargo has been stocked in 17 hours. Other instances are mentioned where with 28 men 2,200 long tons were similarly handled in 15 hours, and 2,100 long tons were handled by 18 men in 17 hours. In using these improved apparatuses in loading from stock piles to railroad cars it is not uncommon to have a gang of men shoveling into buckets and load the ore on cars at the rate of 8 or 9 tons per man per hour.

Receiving docks at some of the blast furnaces located on navigable streams will, together with those above instanced, augment the capital invested in such facilities to an amount equal to the outlay mentioned as demanded for the shipping docks.

The accompanying plates represent receiving docks at Cleveland, Ohio, giving a general view of the bridge tramway plants used in unloading iron ore from vessels, consisting of a series of bridges, supported at their ends upon frames which traverse on rails. On one of the frames is a house containing the motive power, including boiler, hoisting engine, brakes, etc. Each bridge frame has a hinged connection in front, which permits of the apron being moved to suit the hatchways of the vessels. Both front and back frames are mounted on wheels, the first named moving on a single rail and the others on double rails. The buckets are filled in the hold of the vessel, hoisted and lowered to cars below or automatically dumped at the proper place on the dock, as may be required, the varieties of ore being placed in separate piles. A view of the floor of one of the receiving docks, exhibiting the various stock piles and bridge tramway plant, is also given. The third plate illustrates the water side of the receiving dock, showing a rear view of the apron.

### ACKNOWLEDGMENTS.

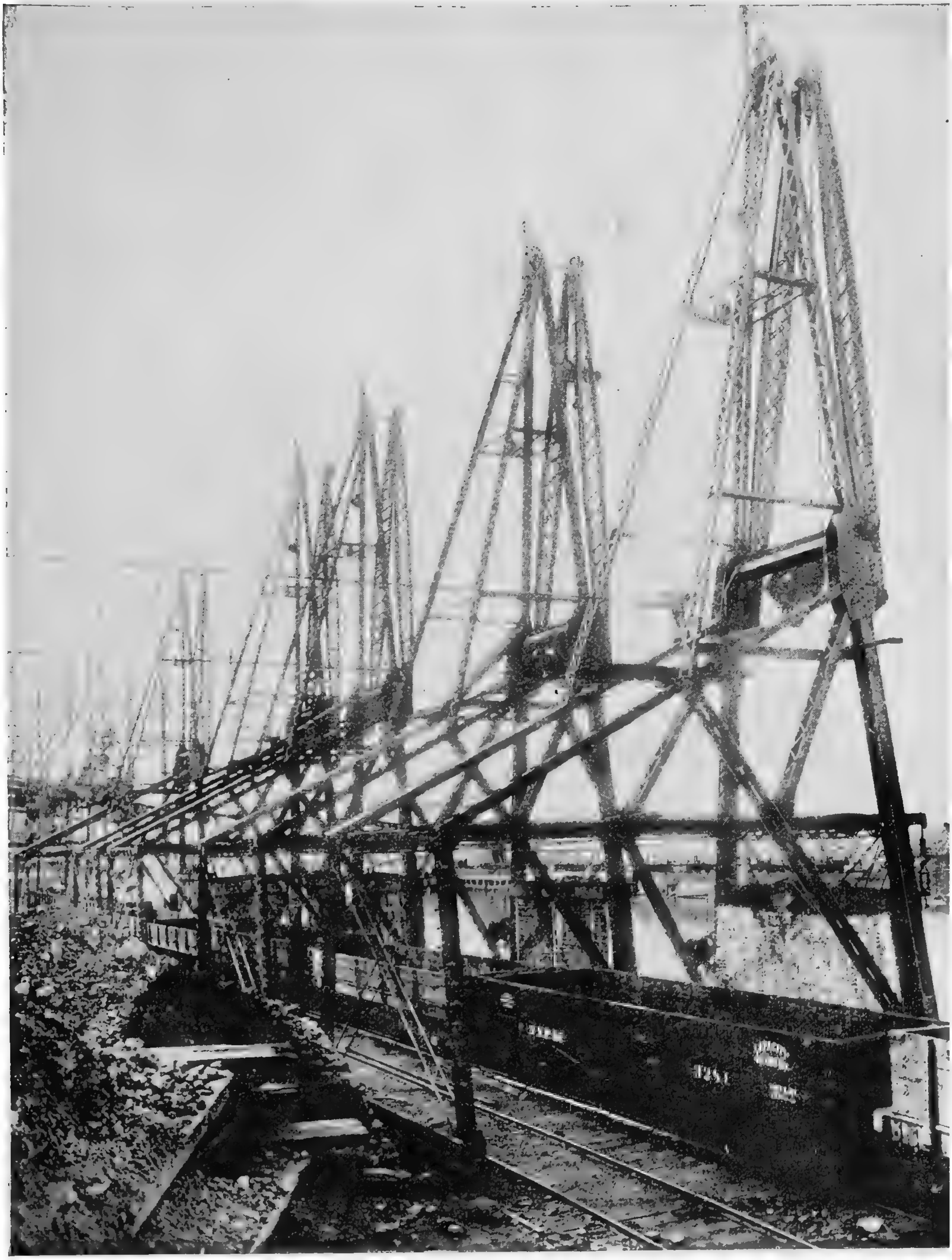
In the collection and preparation of data for publication Mr. F. L. Bitler, of Philadelphia, has served as chief assistant, and his knowledge of iron-ore mines was freely drawn upon.

Mr. Richard A. Parker, of Marquette, Michigan, materially aided in the collection and analyses of the reports of some of the mines in the Lake Superior region, and Mr. H. S. Fleming, of Memphis, Tennessee, rendered similar service in a portion of the southern states.

Professor Raphael Pumpelly courteously placed at the command of the Eleventh Census all the information which he collected for the Tenth Census. This has been of material service.

Data in regard to various states and districts were also furnished by Professor W. B. Potter, Saint Louis, Missouri; Professor J. C. Smock, Trenton, New Jersey; Messrs. S. Norton, Hokendauqua, Pennsylvania; W. J. Stevens, Marquette, Michigan; George W. Goetz, Milwaukee, Wisconsin; Professor Frank L. Nason, New Brunswick, New Jersey, and others.

Obligation is acknowledged to various blast furnace companies and managers who aided by furnishing quantities of iron ore used or lists of parties supplying iron ore, and to the cordial co-operation of the railroad companies and many of those interested in mining and transporting iron ores in the United States.



NEAR VIEW OF "A" FRAMES AND PROJECTING APRONS OF A RECEIVING DOCK. (See page 29.)

The aprons are lowered from the position shown when ore is being taken from vessels.

# GOLD AND SILVER.

# GOLD AND SILVER.

BY RICHARD P. ROTHWELL.

## INTRODUCTION.

The statistics of an industry which in a single year has added to the wealth of the nation in a permanent, indestructible form about $100,000,000, and which within a quarter of a century has increased the supply of the world's standards of value nearly $2,000,000,000, are worthy the careful study of legislators, statesmen, and political economists in every country. With a full appreciation of the vastness of the subject and of the importance of accuracy in statements of such far-reaching influence, it has been sought to render these statistics of the precious metal industry in the United States in the calendar year 1889 full and reliable, especially from the fact of the controlling influence which must necessarily be exerted by the United States as the producer of nearly 28 per cent of all the gold and 41 per cent of the world's entire output of silver. It has also been deemed essential to the usefulness of this report to include in it a discussion of the various conflicting statements of the production of gold and silver in previous years, both in the United States and in all other countries, and to point out as far as possible, from a careful study of the world's statistics, the causes for the great and rapid decline in the market value of silver in recent years and the probable future of that value. These are the most important questions in the precious metal industry, not only to a vast investment in this country, but as affecting the financial policy of the whole civilized world. It has seemed well, therefore, to devote much space to this subject and much study to the facts which census investigations have established.

The successful accomplishment of this investigation has been due to the earnest efforts of many assistants. The principal assistant, Mr. William Kent, has had charge of the work, and has given valuable assistance in the study of the literature of the statistics of gold and silver production. The important duties involved in the care of the finances of this investigation and the general administration of the office were confided to Mrs. Sophia Braeunlich, business manager of the Engineering and Mining Journal. Her devotion and great business ability have contributed largely to the success of the work.

The greatest attention has been devoted to tracing to its source the output of the metals, so that the importance not only of each state, but of each producing county of a state, may be recognized.

The importance attached to the labor statistics has been less than to that of production only because of the impossibility, from the very nature of the industry, of obtaining absolutely exact data on this subject. The fact that much of the gold and the greater part of the silver is now obtained from ores produced or treated for lead or copper, the labor statistics of which naturally come within the statistics of these metals, renders a just apportionment of the labor and capital employed in the production of each metal impossible where the statistics of all have not been collected by the same special agent. Nevertheless, the statistics showing the number of men and the capital employed in the production of the precious metals have received the most careful attention, and are believed to be accurate within narrow limits.

The number of gold and silver mining "claims" or "locations", commonly called "mines", in the United States is practically beyond computation. The names of nearly 100,000 of such claims or mines were received by the Census Office, but upon limiting the investigation to (1) producing mines, (2) mines working but not producing, (3) mines temporarily stopped, but which had produced or upon which the work done had established their value and which could properly be classed as mines, the list declined to perhaps 10,000, and upon tabulating only such mines as made returns of production or labor statistics the list was reduced to 6,004, which is still a very large number compared with the other mineral-producing mines in the United States. Of these final reports, 43 per cent in number were reported direct through correspondence; the balance was collected by agents in the field. It is confidently believed that with time and continuous effort the reports of probably 80 per cent of all the producing mines could be secured by correspondence. This, however, would still leave the necessity for employing agents in the field to collect the remaining 20 per cent.

The results of the census investigation of the precious metal industry in 1889 are summarized on the following page.

### PRODUCTION OF BULLION.

| METALS. | Ounces. | United States coining value. (a) |
|---|---|---|
| Total |  | $99, 283, 732 |
| Gold | 1, 590, 869 | 32, 886, 744 |
| Silver | 51, 354, 851 | 66, 396, 988 |

a Coining value of 1 ounce of fine gold, $20.6721+; coining value of 1 ounce of fine silver, $1.2929+.

### NUMBER OF EMPLOYÉS, AVERAGE WAGES PAID, AND AVERAGE NUMBER OF DAYS EMPLOYED PER YEAR.

| EMPLOYÉS. | Number employed. | Average wages per day. | Average number of days employed per year. | Average wages per year. |
|---|---|---|---|---|
| Grand total | 57, 307 |  |  |  |
| Above ground: |  |  |  |  |
| Foremen or overseers | 1, 585 | $4. 04 | 216 | $873 |
| Mechanics | 3, 273 | 3. 67 | 244 | 895 |
| Laborers | 17, 085 | 2. 51 | 195 | 489 |
| Boys under 16 years of age | 82 | 1. 16 | 199 | 231 |
| Total | 22, 025 |  |  |  |
| Below ground: |  |  |  |  |
| Foremen or overseers | 1, 352 | 4. 16 | 238 | 990 |
| Miners | 29, 144 | 3. 12 | 236 | 736 |
| Laborers | 3, 870 | 2. 46 | 244 | 600 |
| Boys under 16 years of age | 43 | 1. 51 | 208 | 314 |
| Total | 34, 409 |  |  |  |
| Office force | 873 |  |  |  |

Average output per person employed per annum, $1,732; average earnings, $729.

### EXPENDITURES.

| | |
|---|---|
| Total wages paid in 1889 | $40, 412, 022 |
| Paid to contractors | 1, 421, 301 |
| Paid to office force | 1, 347, 373 |
| Total | 43, 180, 696 |
| Value of supplies | 13, 817, 739 |
| Other expenditures | 6, 452, 701 |
| Grand total | 63, 451, 136 |

### VALUE OF MINING PLANT.

| | |
|---|---|
| Buildings | $7, 565, 918 |
| Railroads on surface | 1, 475, 674 |
| Machinery | 14, 985, 215 |
| Underground improvements | 95, 806, 648 |
| Mine supplies | 3, 919, 480 |
| Cash | 4, 112, 810 |
| Estimated value of mines, exclusive of the above items | 338, 094, 821 |
| Total value of mining plant | 465, 960, 566 |

### VALUE OF MILLS AND REDUCTION WORKS.

| | | |
|---|---|---|
| Buildings | $5, 685, 562 | |
| Machinery | 13, 456, 938 | |
| Supplies | 1, 220, 272 | |
| Total | | 20, 362, 772 |
| Total value of mines and works | | 486, 323, 338 |

### MOTIVE POWER.

| POWER. | Number. | Horse power. |
|---|---|---|
| Boilers | 2, 034 | 78, 343 |
| Engines | 1, 364 | 55, 122 |
| Other motors | 623 | 18, 821 |
| Animals | 3, 965 |  |

## RELATIVE IMPORTANCE OF PRODUCING MINES.

| | NUMBER. |
|---|---|
| Mines reported producing less than $1,000 bullion | 1, 610 |
| From $1,000 to $10,000 | 1, 408 |
| From $10,000 to $50,000 | 437 |
| From $50,000 to $100,000 | 95 |
| From $100,000 to $250,000 | 107 |
| From $250,000 to $500,000 | 44 |
| Over $500,000 | 28 |
| Total | 3, 729 |
| Mines reported working but not producing bullion | 1, 009 |
| Mines reported idle | 1, 266 |
| Total number of mines reported | 6, 004 |

The details for the statistics thus summarized are given in the following pages in due sequence.

From these statistics it appears that the labor employed in the actual production of the precious metals is both extremely well paid and very productive—better paid and more productive, in fact, than in any other industry thus far (May, 1891) reported.

The average earnings of all persons employed at the gold and silver mines (57,307) was $729 a year, while the average output per man amounted to $1,732 a year. In the granite quarrying industry, according to the census report, the average value of the output per person employed in 1889 was $648, and the average wages per annum $431. In coal mining west of the Mississippi river the average value of output per person employed was $675, and the average wages earned $474.

The average earnings in the several classes of labor in 1889 and 1880 are compared in the following table. It should be stated that if miners and laborers under ground are classed together, as all classes of labor above ground are, the average wages earned under ground would be $3.04 per day as compared with $2.51 per day above ground.

Miners generally work on contract, so much per ton, per foot of drift, or per cubic yard, while laborers under ground are paid by the day, which accounts for the great difference between the earnings of the two classes. It is well known that the average day wages paid in mining throughout the western states have largely declined during the past 10 years, owing to the reduced cost of living and greater number of wage workers since railroads penetrated the mining districts.

## AVERAGE RATE OF WAGES IN GOLD AND SILVER MINING AT THE ELEVENTH CENSUS COMPARED WITH THE TENTH CENSUS.

| STATES AND TERRITORIES. | ELEVENTH CENSUS. | | | | | | TENTH CENSUS. | |
|---|---|---|---|---|---|---|---|---|
| | Above ground. | | | Below ground. | | | | |
| | Foremen. | Mechanics. | Laborers. | Foremen. | Miners. | Laborers. | Foremen. | Miners. |
| The United States | $4. 04 | $3. 67 | $2. 51 | $4. 16 | $3. 12 | $2. 46 | ........ | ........ |
| Alabama | 3. 00 | 1. 50 | 0. 90 | 3. 00 | 1. 25 | 0. 83 | $1. 00 | $1. 00 |
| Alaska | 5. 50 | 5. 00 | 2. 82 | 4. 86 | 3. 60 | 2. 00 | ........ | ........ |
| Arizona | 4. 59 | 3. 89 | 2. 46 | 4. 44 | 3. 17 | 2. 24 | 5. 00 | 4. 00 |
| California | 3. 30 | 3. 26 | 2. 05 | 3. 49 | 2. 74 | 2. 28 | 5. 00 | 3. 25 |
| Colorado | 4. 33 | 3. 80 | 2. 91 | 4. 22 | 3. 08 | 2. 88 | 5. 00 | 3. 00 |
| Dakota | 4. 57 | 3. 23 | 2. 85 | 4. 75 | 3. 49 | 2. 99 | 5. 50 | 3. 50 |
| Georgia | 1. 33 | 1. 47 | 0. 92 | 1. 60 | 1. 05 | 0. 80 | 2. 00 | 1. 00 |
| Idaho | 4. 64 | 4. 04 | 3. 04 | 4. 79 | 3. 59 | 3. 10 | 5. 00 | 4. 00 |
| Maine | ........ | ........ | ........ | ........ | ........ | ........ | 2. 00 | 1. 50 |
| Maryland | 2. 25 | ........ | 1. 05 | ........ | 1. 50 | 1. 25 | ........ | ........ |
| Michigan | 3. 25 | 2. 25 | 1. 81 | 2. 25 | 2. 00 | 1. 80 | ........ | ........ |
| Montana | 5. 39 | 4. 14 | 3. 25 | 5. 11 | 3. 48 | 3. 13 | 5. 00 | 3. 50 |
| Nevada | 5. 07 | 4. 56 | 3. 22 | 4. 83 | 3. 60 | 2. 91 | 6. 50 | 4. 00 |
| New Hampshire | ........ | ........ | ........ | ........ | ........ | ........ | 3. 00 | 1. 50 |
| New Mexico | 4. 09 | 3. 50 | 2. 31 | 4. 15 | 3. 15 | 2. 26 | 4. 50 | 2. 75 |
| North Carolina | 2. 27 | 1. 44 | 0. 88 | 2. 26 | 1. 02 | 0. 85 | 2. 00 | 1. 00 |
| Oregon | 3. 32 | 2. 92 | 2. 29 | 3. 92 | 3. 16 | 2. 23 | 4. 00 | 3. 00 |
| South Carolina | 3. 02 | 2. 54 | 0. 99 | 3. 10 | 1. 15 | 0. 90 | ........ | ........ |
| Texas | 4. 62 | 2. 83 | 2. 07 | 2. 60 | 1. 27 | 1. 25 | ........ | ........ |
| Utah | 5. 27 | 3. 93 | 3. 14 | 4. 21 | 3. 04 | 2. 80 | 5. 00 | 3. 25 |
| Virginia | 1. 38 | ........ | 1. 00 | ........ | ........ | ........ | 1. 25 | 1. 25 |
| Washington | 5. 00 | 4. 00 | 3. 00 | 4. 69 | 3. 43 | 3. 28 | ........ | 2. 50 |
| Wyoming | 3. 86 | 3. 07 | 2. 36 | 4. 84 | 3. 05 | 2. 36 | 4. 00 | 3. 00 |

## STATISTICAL METHODS.

The collection of statistics respecting the production of gold and silver is a work of great difficulty. Gold is produced in extremely small quantities by a vast number of independent miners, often from remote and almost inaccessible sources. An army of prospectors is scattered over the mountains of the western states and territories every year, who explore every cañon and river bottom by digging and panning, and when "pay gravel" is found will remain working it until the gold or water supply fails or the frosts of winter drive them back toward the abodes of civilization. Gold dust thus found is carried from time to time to the nearest store or village, where it is bartered for supplies, or it is taken to the nearest United States assay office and sold for coin. The prospector, as a rule, carefully conceals the source from which his gold came, fearing lest others might interfere with his "claim", to which he may expect to return and work year after year; though the prospector does not generally return to his old diggings, for he has an ineradicable belief that somewhere else than "here where it requires so much labor for so little gold", somewhere "across the range" or in some still more desolate cañon, the bonanza awaits him which will realize his dream of millions and reward him for all the hardships and dangers he has undergone.

The prospector scorns to work for day wages. The mirage of millions is always before his eyes, and he patiently, cheerfully, and bravely undergoes untold privations and hardship year after year which no mere stipulated reward would induce him to endure, while the value of the gold he actually obtains does not amount to even very modest wages, and frequently does not pay for the scanty provisions with which he supplements the game he shoots. The storekeeper frequently furnishes him the provisions, or, as he terms it, a "grub stake", for an interest in the "finds" he may make.

While the average annual production of each of these prospectors or miners is small, the aggregate amount is considerable; but no full or accurate statistics of this portion of gold production can be obtained. It is frequently impossible to find the prospectors and men who work small mines, or, when found, to get any reliable information from them. They sometimes can not tell how much gold they have produced during the preceding year, the days they worked, the cost of anything, or the value of the mine itself.

Gold is mainly produced by a few large accessible mines, from which it is easy to get statistical information; but the cost of production at such mines would not fairly represent that at small mines or by prospectors.

Since the state of California has practically prohibited hydraulic mining by forbidding the washing of any débris into the streams, the yield of gold has greatly diminished; it has declined far more, in fact, than the entire value of the agricultural lands of the state which could possibly be affected by the débris. It is true that some surreptitious gravel mining is still carried on in the mountains, but from the fact that it is illegal it is impossible to obtain reliable statistics concerning it.

Notwithstanding these many difficulties, which render the collection of full statistics of gold more difficult than those of any other mineral product, it is nevertheless true that the mere total production of the metal can be ascertained with considerable accuracy and ease, since nearly all the gold produced finds its way either to the United States mint or to a few private refineries who supply fine bars.

The director of the United States mint has for some years collected and published an annual report giving the total production of gold in the United States, computed from the deposits at the various mints and United States assay offices and from reports furnished by the private refineries, and from returns by producing properties, the whole checked by the disposition of the products. This report, of course, gives none of the important statistics of labor, supplies, value of mines and improvements, etc., which it was the object of the census investigation to secure; and even where the mint report attempts to distribute the product according to states and counties, still more where it assumes to give the output of individual mines, its figures are manifestly less reliable than required by a careful census of the mines, for while nearly all the gold finds its way to the mint the statistics relating to its production can be accurately obtained only by infinite labor and minute investigation.

The same is true in a less degree of the statistics of silver. This metal is now mainly produced in large mills or metallurgical establishments, which are quite willing to furnish the necessary statistics; but a much smaller proportion of the total silver than of the gold output goes through the mint, and a much larger proportion of it goes directly from the producer into commerce; consequently the figures of total production of silver as given in the mint report are less accurate than those of gold.

The mint reports are extremely valuable, and great credit is due to the director for the promptness with which this important statement of gold and silver production is published each year, and which would be greatly delayed if the work of collecting full statistics were undertaken.

The report on precious metals in volume XIII of the Tenth Census included elaborate reports of a technical character, among which were "A geological sketch of the states and territories of the Pacific division", by Mr. George F. Becker; "A sketch of the Rocky mountain division", by Mr. S. F. Emmons; "The mining industries of Utah", by Mr. D. B. Huntley; "The minting of gold and silver", by Mr. Albert Williams, jr., and "Lead smelting at Leadville, Colorado", by Mr. S. F. Emmons. It also included several minor sketches and reports on the mining and metallurgical methods adopted in the various districts, and various geological and technological data, together with statistical tables, such as the production of ore and bullion, rates of wages, etc.

The collection of statistics for the Eleventh Census is confined to ascertaining, first, the total production of gold and silver in the United States, showing the amount produced in each state and county; and, second, the importance of the industry as measured by (1) the number of persons it supports, (2) the wages earned by those engaged in the industry, and (3) the value of the mines and mining plant.

To furnish data for a correct understanding of the peculiar difficulties under which any census of the gold and silver industry must be conducted, as well as to show the extensive scope of the work undertaken by the census of 1880 and the methods used in it, and the reasons for curtailing that scope and adopting another method for the Eleventh Census, the following extract from the introduction of volume XIII of the Tenth Census is herein presented:

> In undertaking the investigation of the statistics and technology of the precious metal industry of the United States, it was the object of those in charge of the work to make not only a more accurate statistical estimate of the actual product of the precious metals than had hitherto been made, but also to obtain such technical data as to the various processes by which these metals are reduced from their ores as would serve to show the actual condition of the industry, the advances it has made as compared with former periods, and its relative perfection and imperfection as compared with similar industries in other countries.
>
> METHODS EMPLOYED.—In considering, at the outset, the best practical method by which such an investigation could be carried on, it was found that no information could be drawn from the experience of former American studies, inasmuch as no such far-reaching and detailed examination of this industry had ever been attempted in this or any other country, at least as far as could be learned. It was well known, however, to all who took part in making the original plans that precious metal mining and its allied labors presented peculiar obstacles to carrying out such a work, far greater than obtain in other industrial branches, from the fact that it is carried on in regions remote and difficult of access; that its business methods are relatively unsystematic, and that it is often of such a nature as to render those engaged in it extremely unwilling to have their transactions known to the world.
>
> It was evident beforehand that the ordinary system of obtaining statistical information by sending circulars or lists of questions to be answered to all persons in charge of mining operations throughout the country would be impracticable, first, because there were no certain means of obtaining their addresses, and, second, because it was probable that, either through ignorance or unwillingness, a large proportion of the questions would be either imperfectly answered or entirely neglected, and it would be impossible to have any check on the completeness or accuracy of the answers obtained.
>
> The plan finally adopted, therefore, was that of sending to every mine or reduction works in the country men of technical training and familiarity with the subject, to gather the necessary information personally, and assure themselves by local observation of the accuracy of the information obtained.
>
> To aid these examiners a series of questions, arranged in schedules for each branch of mining and reduction process, was prepared after long and careful consideration, which should cover as far as possible all points of inquiry and also furnish checks on the accuracy of data given, intending thus to supplement any shortcoming in technical knowledge on the part of the expert and to systematize the data which he might send so as to facilitate the work of the compiler.
>
> To carry out such a plan to theoretically perfect completion four requisites were necessary: an amount of time and of money disproportionate to the value of the results to be hoped for, a sufficient number of men both theoretically and practically familiar with all branches of the industry to act as experts, and a uniform willingness and ability on the part of those applied to to furnish the desired information.
>
> In point of fact, however, after the work had been some time under way it was found that both the time and the money which could be allotted to this branch were inadequate to carry it through with the perfection aimed at; that it was impossible to find the number of men required who were in every respect fitted for it by education and experience, and that among owners and superintendents of mines and reduction works, while with a very few unimportant exceptions the greatest willingness was shown to grant us all the information they possessed, it was often found that they were themselves unable to answer the questions we asked, either through want of system in keeping records or because they had never thought of the importance or bearing of certain facts.
>
> REASONS FOR INCOMPLETENESS.—The reasons for incompleteness in the results may be thus enumerated:
>
> 1. From want of previous experience the agents in charge could not distribute equally the ground to be covered among the experts employed, since the number of mines to be investigated bore no necessary relation to geographical area. As a consequence, toward the end of the time devoted to the investigation some regions received less attention than their relative importance merited.
> 2. The relative ability of the experts employed was necessarily unknown to the agents in charge until the investigation had proceeded so far that it was too late to make any radical change.
> 3. It was a practical impossibility to secure uniformity of ability and methods among so large a corps of experts as was necessary for the work. The result was that one would give more attention to one class of facts, another to another class, and when totals were made up from the schedule returns it was found that these facts were more complete in one region than in another.
>
> As regards the best method for conducting such an investigation, the experience gained in this study would seem to teach that, while that employed here would produce the most perfect results under very favorable conditions, these conditions might demand an impracticably large expenditure of time and money. They would require a larger corps of experts, who should be specialists and receive adequate salaries, and be employed for a long enough time to become thoroughly familiar with their work before the investigation was undertaken. This could be best accomplished by making the investigation a permanent one. The results to be obtained by simple untrained enumerators, or from circulars sent without means of checking the results obtained by technical men, will necessarily prove so unreliable in the mining industry as to be of little value. Should the intermittent or decennial method still prevail a compromise between the two could be advantageously made by having untrained men go over the country rapidly and collect a few main figures for the statistical tables, and a smaller corps of thoroughly trained specialists make investigation of a few typical mines or reduction works in the various branches of the industry.

Leaving out of consideration the especial difficulties met with in the census of 1880, due to the attempt made to collect technological data as well as purely statistical information concerning production, wages, etc., great obstacles were found in collecting even the statistics of bullion production alone, and much of the product had to be estimated. The following extracts from the report of the Tenth Census (1880) show the difficulties then experienced in collecting statistics of production. The same difficulties were encountered to some extent in the present census of 1890, though, thanks to the work performed annually by the mint, the production returns are now much more willingly furnished than they were in 1880.

Three principal methods have been adopted by statisticians in studying the bullion production of the United States.

The first and most obvious plan has been to use as a basis the receipts of domestic bullion reported by the several mints and United States assay offices, ascertaining the probable total product by adding to the figures thus obtained the amount shipped abroad, as shown by the customhouse returns, and the probable amount consumed in the arts. The objections to this method are: The amount coined within a certain period does not necessarily correspond to the production for that period. In the same way the proportion of the domestic product exported may be largely affected by the stock of precious metals on hand at any given time. Both of these variations depend primarily upon fluctuations in the bullion market and international balance of trade. An average of a long series of years would give tolerably accurate results, but for any stated period the figures of coinage, export, and consumption in the arts are apt to be deceptive.

Assuming the source of the bullion deposited at the mints to be correctly stated, there are still serious and unavoidable defects in the customhouse statistics, notwithstanding the care taken to secure accuracy. No account is taken of bullion transported overland into Canada, nor are the export figures for doré bullion, base bullion, ores, and matte shipped abroad always to be depended upon. * * *

The best results which can be hoped for from the most careful application of the "consumption and export" method are close approximations extending over considerable periods, but not the exact product for any given year. The system also fails to segregate the yield according to the productive source; and while the geographical distribution by state and territorial lines may be shown, it is hardly possible to carry the analysis further and ascertain in this way the yield of single districts or even counties. * * *

The second or "transportation" method consists in estimating the product from the statistics of the express companies, freight lines, and banks which have the handling of the product from its original sources. This plan would give more satisfactory results if, in the first place, all the bullion, ores, etc., were transported from the producing points through these different channels alone, and if, in the second place, none of the product were reshipped from point to point and thus twice recorded. As a matter of fact, there is a considerable portion of the gold yield sent through the mails as registered matter, and a large proportion passes from the productive source into the market through private channels. * * * But the impossibility of assigning to other channels the due proportion of the outflow through them; the fact that no record is made of the value of the gold bullion and dust sent through the mails; that no reliable allowance can be made for the undervaluation of gold dust and unassayed bullion by consignors, amounting in many cases to from 5 to 10 per cent; that there is no satisfactory means of checking the reshipments which are twice or more times recorded, combine to create a large margin which can hardly be definitely accounted for in making the total estimates. * * *

The third system is one which, were it practicable to pursue it into complete details, would lead to results more satisfactory than could be obtained in any other way. This may be termed the direct method. It would consist, if properly carried out, in obtaining from each bullion producer a statement of the quota contributed. The aggregate of the details thus reached would represent the actual total product of the country and would, moreover, segregate it according to districts. * * *

The chief obstacles encountered in the collection of bullion statistics directly from the producers were:

First. The wide extent of the field to be covered and the vast number of mines to be reported upon. Even were the mines located in easily accessible places, the wide range of territory over which they are scattered would render the labor of personally visiting each productive district a tedious matter; but when it is considered that they are for the most part to be found in rugged, mountainous tracts, often at high altitudes, and, when destitute of railroad communication, to be reached only by stage or on horseback, some idea may be gathered of the amount of work involved.

Second. The fact that a considerable yield is derived from small mines, the product from each of which, however insignificant in itself, goes to form part of an important aggregate, and should not be neglected.

Third. The reluctance of some mine owners and superintendents to give a full account of their operations, notwithstanding the strictly confidential manner in which these individual statements have been treated. * * *

Fourth. The fact that in a large majority of cases no systematic accounts are kept by mine owners, who were often unable to state from memory the precise output of their properties for a period which had elapsed some time before the inquiry was made.

Fifth. Many mines having changed hands during the census year, it was frequently impossible to obtain from the present holders a statement of the operations conducted prior to the change in ownership, or to communicate with the former owners if they had removed. * * *

With means still less adequate than were lately at command, the census authorities in 1870 found it impossible to trace the bullion product of the country at that time. The best results reached by the deputy marshals in certain instances hardly amounted to a moiety of the actual product as known through other sources of information. In the case of the census of 1880, even with greatly increased facilities, there were many gaps in the testimony which had to be filled out by estimates derived from other data than those collected directly by the experts. * * *

In compiling the material at hand the following system was adopted: The returns given in the individual mine schedules were first abstracted and grouped into aggregates for districts. Information as to the operations of the different establishments being in many cases confidential, publication of the results begins with the district exhibits. These, again, are condensed into tables for counties, and finally into abstracts for whole states and territories. Where a marked discrepancy existed between the schedule returns and other reliable data, the necessary additions were entered and the fact that they were estimates indicated. It is hardly necessary to remark that the schedules would show deficiencies rather than an excess as compared with correlative data. At the same time the schedules of reduction works were examined, and furnished a valuable check upon the figures derived from the mine reports. * * *

The collection of statistics of the precious metals in Colorado presents certain peculiar difficulties: First, from the fact that there are so many small mines which keep no accurate record of their production; second, because a very large proportion of its ores, being essentially heterogeneous in composition, have to be smelted, and are thus more difficult to trace than milling ores. The smelting ores are sold, it is true, mostly to smelters within the state, but the same mine often sells to different and widely separated works, and the smelters themselves buy ores in small lots from many mines, of which no separate record is kept. Moreover, the check furnished in the more western states over the total production by the express returns is here wanting, since, practically, the whole silver product is shipped east in lead bullion, of which the transportation companies keep no record. Nevertheless, owing to the almost uniform willingness which the more important mine owners, samplers, and smelters have shown to afford the data which they possessed, it is believed that the totals attained represent a very close approximation to the actual product of the state, and that the figures given are, on an average, within 5 per cent of the true amount, although in districts as yet incompletely developed this percentage may be greater.

As it was found impossible to separate with any degree of approximation the amount of "bullion produced", which should be credited to individual districts in several counties, the division into districts has been abandoned in such instances. In the following tables the amount and value of ore raised has been given to districts as far as was possible, the heading "scattered" including, in general, mines from which no direct information was obtained, but which had sold ore to samplers or smelters. The sign of "estimated" (*) might be appended in many cases to amounts of bullion produced by counties, because these amounts were largely obtained by segregating returns of ore purchased by smelters and apportioning to each county the corresponding proportion of bullion produced from that ore; thus, while the relative amounts may be considered estimates, the total footings of the columns are compiled from comparatively accurate data. * * *

MONTANA.—It was evident that the figures of gold production deduced from the schedules were below the truth, since the mint returns report the gold production of Montana as a little over a million dollars in excess. As the mint figures are certainly below the truth, it was proper that this difference should be added, the only question being to what branch of mining it should be credited. Now, the census returns from placer and hydraulic mines were notoriously incomplete, since, owing to the lateness of the season, but few of their owners could be found; but it is well known that they form the most important element in the gold production of Montana. On the other hand, it was thought that returns had been obtained from practically all the mills and smelting works. Under these circumstances it was judged best to discard the census figures for hydraulic and placer mines altogether, and assume as their production the difference between the amount of gold produced, as determined by mill and smelters returns, and the total product obtained from mint returns. * * *

The difficulties of obtaining reliable statistics of gold and silver productions were somewhat increased at the Eleventh Census by the stricter limitation of time and money to be devoted to this branch of the census, but all have been largely overcome by adopting the method successfully used in collecting annual statistics of other minerals, which consists in sending circulars containing a list of questions to be answered to all persons in charge of the mining operations throughout the country, and later to supplement this work by the employment of subagents, who should personally verify the schedules and obtain statistics of those mines which had not made returns by mail. No complete list of all the gold and silver mines in the United States existed. Very imperfect lists of those in a few states were given in the reports of the director of the mint and of various state officials, but by using these and other sources of information as a starting point it was found possible to compile fairly accurate and complete lists of all mines of any importance.

The likelihood of the schedule questions relating to works and mines being unanswered or answered incorrectly would evidently be greatly reduced by making the number of these questions as few as possible, and making them so simple that there would be no difficulty in understanding them.

The plan adopted for obtaining a directory of the mines was as follows: A circular was sent to every postmaster, assessor, county clerk, and newspaper editor in each mining district, and to the superintendents of mines whose post-office addresses could be ascertained, inclosing to each such person a blank on which he was requested to write and return the names and post-office addresses of all mines in his immediate vicinity. By this means many thousand names of mines were obtained. A second circular was then sent to the superintendent of each of these mines, including blanks worded as follows:

Name of mine, ———; location, town or district, ———; kind of metal produced—gold, silver, copper, lead, etc., ———; name of resident superintendent, ———; post-office address of superintendent, ———; name of company or owner, ———; address of principal office of company or owner, ———; operated or not in 1889, ———.

A directory blank was also sent to each mine superintendent, requesting him to fill in the names and addresses of neighboring mines. With the returns received from this second series of circulars the provisional list of mines was corrected and enlarged, and by following up this system a fairly accurate and complete list of addresses and names was obtained. To the managers of these mines were mailed the schedules with questions relating to the production of each mine and reduction works. The form of the schedule is shown in the appendix.

Had unlimited time been allowed, unquestionably nearly all the important mines could have been reached and returns obtained from them in this simple and inexpensive manner, but there would always remain a certain number of mines unreported which would necessitate the personal visit of an agent to get the desired information. This was foreseen, and without waiting to reach the limit obtainable by correspondence special agents were appointed from each mining state and territory, to whom were furnished lists of the mines which had made returns, as well as those which had not. These agents were instructed to visit the mines which had not reported and such as were not on the lists and have the schedules filled out and returned at the earliest possible date. In Colorado and California special subagents were appointed for each mining county, or in some cases for a group of counties. In some states one, two, or more subagents were appointed to collect the schedules, and after seeing that they were properly filled out to return them to the office in New York, where all the compiling and tabulating were done.

This dual method of collecting by mail and by personal visits has proved satisfactory. The number of schedules received by mail was 2,584; the number received through agents after personal visits was 3,420; total, 6,004. In other words, 43 per cent of all the mines and about 60 per cent of the total production and other statistics of gold and silver were obtained by correspondence.

As fast as the schedules were received at the office in New York they were examined and tabulated, first by post offices and districts, and then these were grouped into counties and states. The county and state totals only are given in this report.

## STATISTICS OF PRODUCTION OF PRECIOUS METALS IN THE UNITED STATES PRIOR TO 1889.

In collecting the statistics of precious metal production for the Eleventh Census, it has been considered essential to make a careful study of existing statistics of production for previous years for the purpose of determining the degree of credit to which those statistics are entitled, as well as to justify the acceptance of the figures which have been collected for this report. It has also been considered important that this report should furnish, with such comment as seemed needed to render available to other students, all the statistical information obtainable concerning the precious metal industry. With this object in view, the statistical statements published in the various mint and other government reports, and collected from other sources considered reliable, are given.

PRODUCTION OF GOLD AND SILVER IN THE UNITED STATES FROM 1792.

[The estimate for 1792-1873 is by Dr. R. W. Raymond, United States mining commissioner, and since by the director of the mint.]

| YEARS. | Total. | Gold. | Silver. | YEARS. | Total. | Gold. | Silver. |
|---|---|---|---|---|---|---|---|
| Total | $2,766,152,769 | $1,838,861,769 | $927,291,000 | 1866 | $63,500,000 | $53,500,000 | $10,000,000 |
| | | | | 1867 | 65,225,000 | 51,725,000 | 13,500,000 |
| April 2, 1792—July 31, 1834 | 14,000,000 | 14,000,000 | (*a*) | 1868 | 60,000,000 | 48,000,000 | 12,000,000 |
| July 31, 1834—Dec. 31, 1844 | 7,750,000 | 7,500,000 | 250,000 | 1869 | 61,500,000 | 49,500,000 | 12,000,000 |
| 1845 | 1,058,327 | 1,008,327 | 50,000 | 1870 | 66,000,000 | 50,000,000 | 16,000,000 |
| 1846 | 1,189,357 | 1,139,357 | 50,000 | 1871 | 66,500,000 | 43,500,000 | 23,000,000 |
| 1847 | 939,085 | 889,085 | 50,000 | 1872 | 64,750,000 | 36,000,000 | 28,750,000 |
| 1848 | 10,050,000 | 10,000,000 | 50,000 | 1873 | 71,750,000 | 36,000,000 | 35,750,000 |
| 1849 | 40,050,000 | 40,000,000 | 50,000 | 1874 | 70,800,000 | 33,500,000 | 37,300,000 |
| 1850 | 50,050,000 | 50,000,000 | 50,000 | 1875 | 65,100,000 | 33,400,000 | 31,700,000 |
| 1851 | 55,050,000 | 55,000,000 | 50,000 | 1876 | 78,700,000 | 39,900,000 | 38,800,000 |
| 1852 | 60,050,000 | 60,000,000 | 50,000 | 1877 | 86,700,000 | 46,900,000 | 39,800,000 |
| 1853 | 65,050,000 | 65,000,000 | 50,000 | 1878 | 96,400,000 | 51,200,000 | 45,200,000 |
| 1854 | 60,050,000 | 60,000,000 | 50,000 | 1879 | 79,700,000 | 38,900,000 | 40,800,000 |
| 1855 | 55,050,000 | 55,000,000 | 50,000 | 1880 | 75,200,000 | 36,000,000 | 39,200,000 |
| 1856 | 55,050,000 | 55,000,000 | 50,000 | 1881 | 77,700,000 | 34,700,000 | 43,000,000 |
| 1857 | 55,050,000 | 55,000,000 | 50,000 | 1882 | 79,300,000 | 32,500,000 | 46,800,000 |
| 1858 | 50,500,000 | 50,000,000 | 500,000 | 1883 | 76,200,000 | 30,000,000 | 46,200,000 |
| 1859 | 50,100,000 | 50,000,000 | 100,000 | 1884 | 79,600,000 | 30,800,000 | 48,800,000 |
| 1860 | 46,150,000 | 46,000,000 | 150,000 | 1885 | 83,400,000 | 31,800,000 | 51,600,000 |
| 1861 | 45,000,000 | 43,000,000 | 2,000,000 | 1886 | 86,000,000 | 35,000,000 | 51,000,000 |
| 1862 | 43,700,000 | 39,200,000 | 4,500,000 | 1887 | 86,350,000 | 33,000,000 | 53,350,000 |
| 1863 | 48,500,000 | 40,000,000 | 8,500,000 | 1888 | 92,370,000 | 33,175,000 | 59,195,000 |
| 1864 | 57,100,000 | 46,100,000 | 11,000,000 | 1889 { mint | 97,446,000 | 32,800,000 | 64,646,000 |
| 1865 | 64,475,000 | 53,225,000 | 11,250,000 | 1889 { census | 99,283,732 | 32,886,744 | 66,396,988 |

*a* Insignificant.

The above figures, especially for the years prior to 1879, vary considerably in many cases from those published in earlier reports, the latter being made up from estimates made at the time and based upon returns which were often greatly exaggerated. Thus in the above table the total bullion production of 1866 is given as $63,500,000, while the original report published in 1867 gave it at $106,000,000.

The following table shows the earliest attempts in official reports to distribute the bullion product among the states and territories. Some of these totals have been greatly reduced in subsequent reports of the director of the mint, as is shown in the latest mint estimates, given herewith.

PRODUCTION OF GOLD AND SILVER IN THE UNITED STATES FROM 1866 TO 1876, INCLUSIVE.

| STATES AND TERRITORIES. | 1866. | 1867. | 1868. | 1869. | 1870. | 1871. | 1872. | 1873. | 1874. | 1875. | 1876. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | $106,000,000 | $75,000,000 | $67,000,000 | $61,500,000 | $66,000,000 | $66,663,000 | $63,943,857 | $71,642,523 | $72,428,206 | $74,817,596 | $85,250,000 |
| Arizona | .......... | 500,000 | 500,000 | 1,000,000 | 800,000 | 800,000 | 625,000 | 500,000 | 487,000 | 750,000 | .......... |
| California | 25,000,000 | 25,000,000 | 22,000,000 | 22,500,000 | 25,000,000 | 20,000,000 | 19,049,098 | 18,025,722 | 20,300,531 | 17,753,151 | .......... |
| Colorado | 17,000,000 | 2,500,000 | 3,250,000 | 4,000,000 | 3,675,000 | 4,663,000 | 4,661,465 | 4,020,263 | 5,188,510 | 5,302,810 | .......... |
| Idaho | 17,000,000 | 6,500,000 | 7,000,000 | 7,000,000 | 6,000,000 | 5,000,000 | 2,695,870 | 2,500,000 | 1,880,004 | 1,750,000 | .......... |
| Montana | 18,000,000 | 12,000,000 | 15,000,000 | 9,000,000 | 9,100,000 | 8,050,000 | 6,068,339 | 5,178,047 | 3,844,722 | 3,573,600 | .......... |
| Nevada | 16,000,000 | 20,000,000 | 14,000,000 | 14,000,000 | 16,000,000 | 22,500,000 | 25,548,801 | 35,254,507 | 35,452,233 | 40,478,369 | .......... |
| New Mexico | .......... | 500,000 | 250,000 | 500,000 | 500,000 | 500,000 | 500,000 | 500,000 | 500,000 | 325,000 | .......... |
| Oregon and Washington. | 8,000,000 | 3,000,000 | 4,000,000 | 3,000,000 | 3,000,000 | 2,500,000 | 2,000,000 | 1,585,784 | 763,605 | 1,246,978 | .......... |
| Utah | .......... | .......... | .......... | .......... | 1,300,000 | 2,300,000 | 2,445,284 | 3,778,200 | 3,911,601 | 3,137,688 | .......... |
| Wyoming | .......... | .......... | .......... | .......... | 100,000 | 100,000 | 100,000 | 50,000 | .......... | .......... | .......... |
| Other sources | 5,000,000 | 5,000,000 | 1,000,000 | 500,000 | 525,000 | 250,000 | 250,000 | 250,000 | 100,000 | 500,000 | .......... |
| Latest mint estimate. | 63,500,000 | 65,225,000 | 60,000,000 | 61,500,000 | 66,000,000 | 66,500,000 | 64,750,000 | 71,750,000 | 70,800,000 | 65,100,000 | 78,700,000 |
| Gold | 53,500,000 | 51,725,000 | 48,000,000 | 49,500,000 | 50,000,000 | 43,500,000 | 36,000,000 | 36,000,000 | 33,500,000 | 33,400,000 | 39,900,000 |
| Silver | 10,000,000 | 13,500,000 | 12,000,000 | 12,000,000 | 16,000,000 | 23,000,000 | 28,750,000 | 35,750,000 | 37,300,000 | 31,700,000 | 38,800,000 |

## APPROXIMATE DISTRIBUTION OF THE GOLD PRODUCT, BY STATES AND TERRITORIES, ESTIMATED BY THE DIRECTOR OF THE MINT.

| STATES AND TERRITORIES. | 1877. | 1878. | 1879. | 1880. | 1881. | 1882. | 1883. |
|---|---|---|---|---|---|---|---|
| Total | $45, 100, 000 | $47, 226, 107 | $38, 900, 000 | $36, 000, 000 | $34, 700, 000 | $32, 500, 000 | $30, 000, 000 |
| Alabama | | | | | | | |
| Alaska | | | | 6, 000 | 15, 000 | 150, 000 | 300, 000 |
| Arizona | 300, 000 | 500, 000 | 800, 000 | 400, 000 | 1, 060, 000 | 1, 065, 000 | 950, 000 |
| California | 15, 000, 000 | 15, 260, 679 | 17, 600, 000 | 17, 500, 000 | 18, 200, 000 | 16, 800, 000 | 14, 120, 000 |
| Colorado | 3, 000, 000 | 3, 366, 404 | 3, 225, 000 | 3, 200, 000 | 3, 300, 000 | 3, 360, 000 | 4, 100, 000 |
| Dakota | 2, 000, 000 | 3, 000, 000 | 2, 420, 000 | 3. 600, 000 | 4, 000, 000 | 3, 300, 000 | 3, 200, 000 |
| Georgia | 100, 000 | 100, 000 | 90, 000 | 120, 000 | 125, 000 | 250, 000 | 199, 000 |
| Idaho | 1, 500, 000 | 1, 150, 000 | 1, 200, 000 | 1, 980, 000 | 1, 700, 000 | 1, 500, 000 | 1, 400, 000 |
| Michigan | | | | | | | |
| Montana | 3, 200, 000 | 2, 260, 511 | 2, 500, 000 | 2, 400, 000 | 2, 330, 000 | 2, 550, 000 | 1, 800, 000 |
| Nevada | 18, 000, 000 | 19, 546, 513 | 9, 000, 000 | 4, 800, 000 | 2, 250, 000 | 2, 000, 000 | 2, 520, 000 |
| New Mexico | 175, 000 | 175, 000 | 125, 000 | 130, 000 | 185, 000 | 150, 000 | 280, 000 |
| North Carolina | 100, 000 | 150, 000 | 90, 000 | 95. 000 | 115, 000 | 190, 000 | 167, 000 |
| Oregon | 1, 000, 000 | 1, 000, 000 | 1, 150, 000 | 1, 090, 000 | 1, 100, 000 | 830, 000 | 660, 000 |
| South Carolina | | | | 15, 000 | 35, 000 | 25, 000 | 56, 500 |
| Tennessee | | | | | 5, 000 | | |
| Texas | | | | | | | |
| Utah | 350, 000 | 392, 000 | 575, 000 | 210, 000 | 145, 000 | 190, 000 | 140, 000 |
| Virginia | 50, 000 | | | 10, 000 | 10, 000 | 15, 000 | 6, 000 |
| Washington | 300, 000 | 300, 000 | 75, 000 | 410, 000 | 120, 000 | 120, 000 | 80, 000 |
| Wyoming | | | | 20, 000 | 5, 000 | 5, 000 | 4, 000 |
| Other sources, not distributed (*a*) | 25, 000 | 25, 000 | 50, 000 | 14, 000 | | | 17, 500 |
| Latest mint estimate | 46, 900, 000 | 51, 200, 000 | 38, 900, 000 | 36, 000, 000 | 34, 700, 000 | 32, 500, 000 | 30, 000, 000 |

| STATES AND TERRITORIES. | 1884. | 1885. | 1886. | 1887. | 1888. | 1889. | |
|---|---|---|---|---|---|---|---|
| | | | | | | Mint. | Census. |
| Total | $30, 800, 000 | $31, 801, 000 | $34, 869, 000 | $33, 136, 000 | $33, 167, 500 | $32, 967, 000 | $32. 886, 744 |
| Alabama | | | | | | | 2, 539 |
| Alaska | 200, 000 | 300, 000 | 446, 000 | 675, 000 | 850, 000 | 900, 000 | 904, 650 |
| Arizona | 930, 000 | 880, 000 | 1, 110, 000 | 830, 000 | 871, 500 | 900, 000 | 910, 174 |
| California | 13, 600, 000 | 12, 700, 000 | 14, 725, 000 | 13, 400, 000 | 12, 750, 000 | 13, 000, 000 | 12, 586, 722 |
| Colorado | 4, 250, 000 | 4, 200, 000 | 4, 450, 000 | 4, 000, 000 | 3, 758, 000 | 3, 500, 000 | 3. 883, 859 |
| Dakota | 3, 300, 000 | 3, 200, 000 | 2, 700, 000 | 2, 400, 000 | 2, 600, 000 | 2, 900, 000 | 3, 091, 137 |
| Georgia | 137, 000 | 136, 000 | 152, 500 | 110, 000 | 104, 000 | 107, 000 | 107, 605 |
| Idaho | 1, 250, 000 | 1, 800, 000 | 1, 800, 000 | 1, 900, 000 | 2, 400, 000 | 2, 000, 000 | 1, 984, 159 |
| Michigan | | | | 26, 000 | 42, 000 | 70, 000 | 87, 040 |
| Montana | 2, 170, 000 | 3, 300, 000 | 4, 425, 000 | 5, 230, 000 | 4, 200, 000 | 3, 500, 000 | 3, 139, 327 |
| Nevada | 3, 500, 000 | 3, 100, 000 | 3, 090, 000 | 2, 500, 000 | 3. 525, 000 | 3, 000, 000 | 3. 506, 295 |
| New Mexico | 300, 000 | 800, 000 | 400, 000 | 500, 000 | 602, 000 | 1, 000, 000 | 815, 655 |
| North Carolina | 157, 000 | 152, 000 | 175, 000 | 225, 000 | 136, 000 | 145, 000 | 146, 795 |
| Oregon | 660, 000 | 800, 000 | 990, 000 | 900, 000 | 825, 000 | 1, 200, 000 | 964, 309 |
| South Carolina | 57, 000 | 43, 000 | 37, 500 | 50, 000 | 39, 000 | 45, 000 | 46, 853 |
| Tennessee | | | | | | | |
| Texas | | | | | | | 6, 828 |
| Utah | 120, 000 | 180, 000 | 216, 000 | 220, 000 | 290, 000 | 500, 000 | 487, 666 |
| Virginia | 2, 000 | | | | | | 4, 100 |
| Washington | 85, 000 | 120, 000 | 147, 000 | 150, 000 | 145, 000 | 175, 000 | 186, 150 |
| Wyoming | 6, 000 | | | | | | 14, 512 |
| Other sources, not distributed (*a*) | 76, 000 | 90, 000 | 5, 000 | 20, 000 | 30, 000 | 25, 000 | *b*10, 369 |
| Latest mint estimate | 30, 800, 000 | 31, 800, 000 | 35, 000, 000 | 33, 000, 000 | 33, 175, 000 | 32, 800, 000 | |

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*a* In some years this is stated to include Alabama, Michigan, Tennessee, Texas, Vermont, Virginia, and Wyoming.

*b* Maryland.

### APPROXIMATE DISTRIBUTION OF THE SILVER PRODUCT, BY STATES AND TERRITORIES, ESTIMATED BY THE DIRECTOR OF THE MINT.

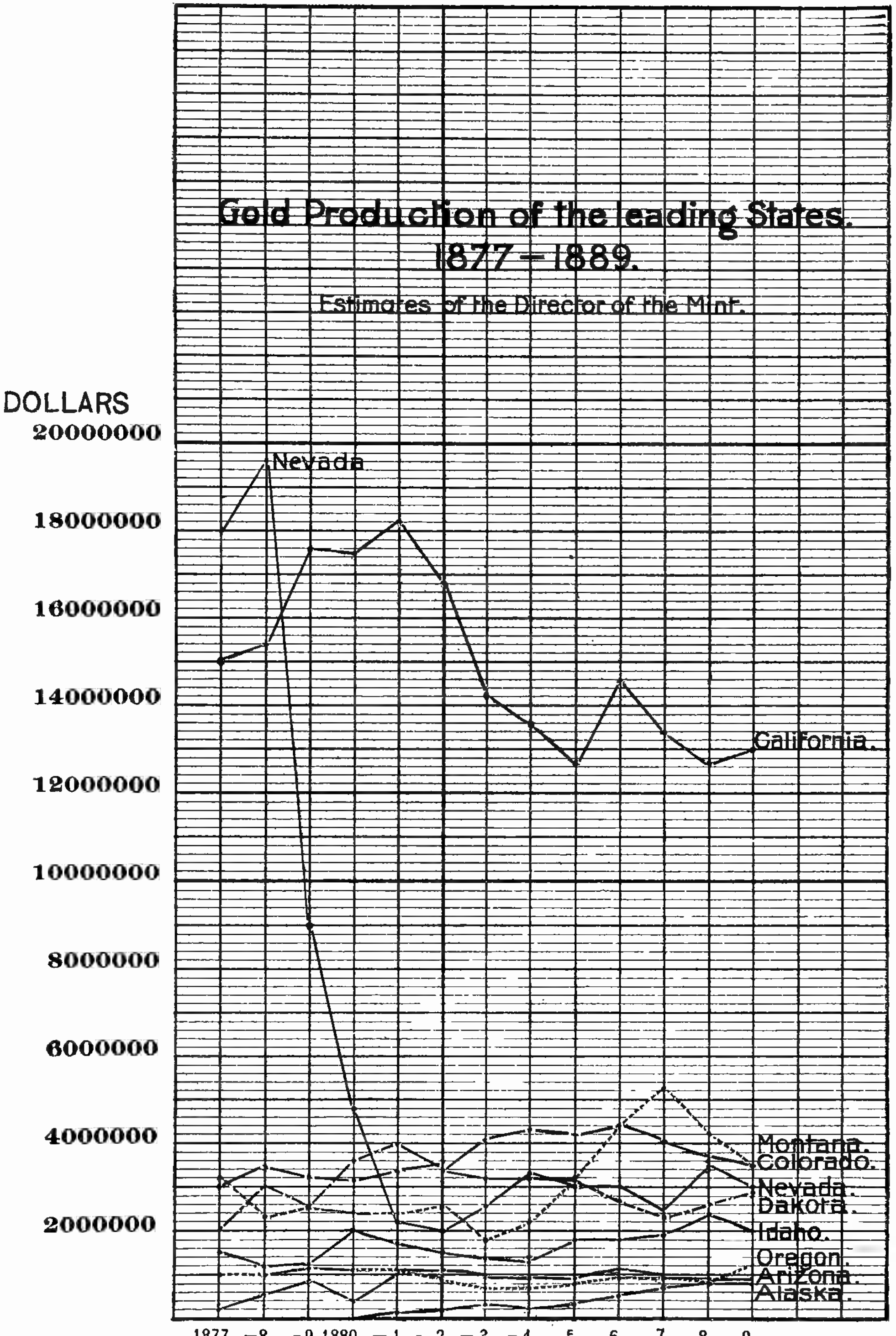
[United States coining value.]

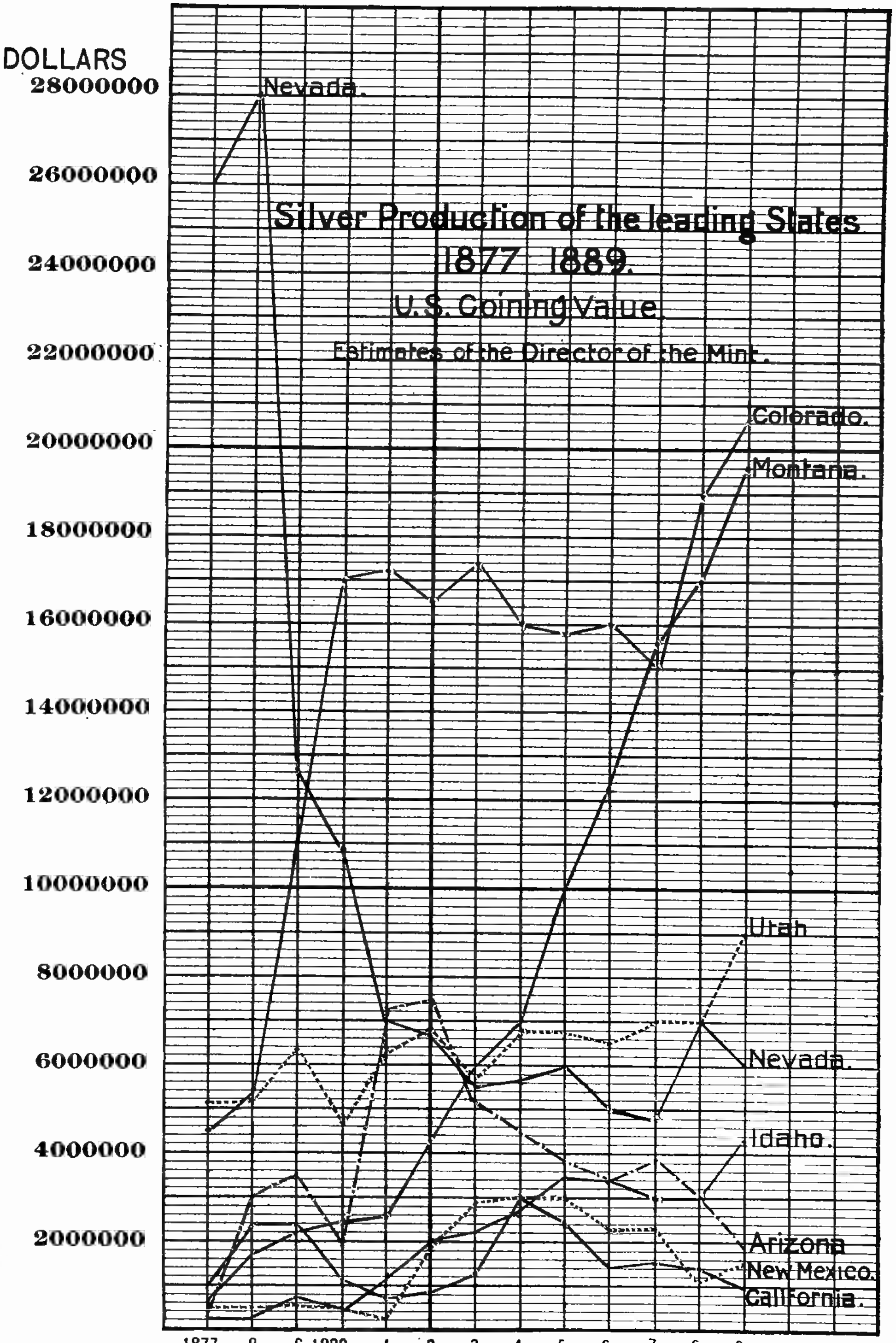
| STATES AND TERRITORIES. | 1877. | 1878. | 1879. | 1880. | 1881. | 1882. | 1883. |
|---|---|---|---|---|---|---|---|
| Total | $38, 950, 000 | $46, 726, 314 | $40, 812, 000 | $39, 200, 000 | $43, 000, 000 | $46, 800, 000 | $46, 200, 000 |
| Alabama | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Alaska | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Arizona | 500, 000 | 3, 000, 000 | 3, 550, 000 | 2, 000, 000 | 7, 300, 000 | 7, 500, 000 | 5, 200, 000 |
| California | 1, 000, 000 | 2, 373, 389 | 2, 400, 000 | 1, 100, 000 | 750, 000 | 845, 000 | 1, 460, 000 |
| Colorado | 4, 500, 000 | 5, 394, 940 | 11, 700, 000 | 17, 000, 000 | 17, 160, 000 | 16, 500, 000 | 17, 370, 000 |
| Dakota | ........ | ........ | 10, 000 | 70, 000 | 70, 000 | 175, 000 | 150, 000 |
| Georgia | ........ | ........ | ........ | ........ | ........ | ........ | 1, 000 |
| Idaho | 250, 000 | 200, 000 | 650, 000 | 450, 000 | 1, 300, 000 | 2, 000, 000 | 2, 100, 000 |
| Maine | ........ | ........ | ........ | ........ | 5, 000 | ........ | ........ |
| Michigan | 200, 000 | 100, 000 | 780, 000 | ........ | ........ | ........ | ........ |
| Montana | 750, 000 | 1, 669, 635 | 2, 225, 000 | 2, 500, 000 | 2, 630, 000 | 4, 370, 000 | 6, 000, 000 |
| Nevada | 26, 000, 000 | 28, 130, 350 | 12, 560, 000 | 10, 900, 000 | 7, 060, 000 | 6, 750, 000 | 5, 430, 000 |
| New Mexico | 500, 000 | 500, 000 | 600, 000 | 425, 000 | 275, 000 | 1, 800, 000 | 2, 845, 000 |
| North Carolina | ........ | ........ | ........ | ........ | ........ | 25, 000 | 3, 000 |
| Oregon | 100, 000 | 100, 000 | 20, 000 | 15, 000 | 50, 000 | 35, 000 | 20, 000 |
| South Carolina | ........ | ........ | ........ | ........ | ........ | ........ | 500 |
| Texas | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Utah | 5, 075, 000 | 5, 208, 000 | 6, 250, 000 | 4, 740, 000 | 6, 400, 000 | 6, 800, 000 | 5, 620, 000 |
| Virginia | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Washington | 50, 000 | 25, 000 | 20, 000 | ........ | ........ | ........ | 500 |
| Other sources, not distributed (*a*) | 25, 000 | 25, 000 | 47, 000 | ........ | ........ | ........ | ........ |
| Latest mint estimate | 39, 800, 000 | 45, 200, 000 | 40, 800, 000 | 39, 200, 000 | 43, 000, 000 | 46, 800, 000 | 46, 200, 000 |

| STATES AND TERRITORIES. | 1884. | 1885. | 1886. | 1887. | 1888. | 1889. | |
|---|---|---|---|---|---|---|---|
| | | | | | | Mint. | Census. |
| Total | $48, 800, 000 | $51, 600, 000 | $51, 321, 500 | $53, 941, 800 | $59, 206, 700 | $64, 768, 730 | $66, 396, 988 |
| Alabama | ........ | ........ | ........ | ........ | ........ | ........ | 100 |
| Alaska | ........ | 2, 000 | 2, 000 | 300 | 3, 000 | 10, 343 | 11, 918 |
| Arizona | 4, 500, 000 | 3, 800, 000 | 3, 400, 000 | 3, 800, 000 | 3, 000, 000 | 1, 939, 393 | 2, 343, 977 |
| California | 3, 000, 000 | 2, 500, 000 | 1, 400, 000 | 1, 500, 000 | 1, 400, 000 | 1, 034, 343 | 1, 373, 807 |
| Colorado | 16, 000, 000 | 15, 800, 000 | 16, 000, 000 | 15, 000, 000 | 19, 000, 000 | 20, 686, 868 | 23, 757, 751 |
| Dakota | 150, 000 | 100, 000 | 425, 000 | 540, 000 | 100, 000 | 64, 646 | 135, 331 |
| Georgia | ........ | ........ | 1, 000 | 500 | 500 | 465 | 464 |
| Idaho | 2, 720, 000 | 3, 500, 000 | 3, 600, 000 | 3, 000, 000 | 3, 000, 000 | 4, 395, 959 | 4, 056, 482 |
| Maine | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Michigan | ........ | ........ | ........ | 35, 000 | 84, 000 | 77, 575 | 18, 885 |
| Montana | 7, 000, 000 | 10, 060, 000 | 12, 400, 000 | 15, 500, 000 | 17, 000, 000 | 19, 393, 939 | 17, 468, 960 |
| Nevada | 5, 600, 000 | 6, 000, 000 | 5, 000, 000 | 4, 900, 000 | 7, 000, 000 | 6, 206, 060 | 6, 072, 241 |
| New Mexico | 3, 000, 000 | 3, 000, 000 | 2, 300, 000 | 2, 300, 000 | 1, 200, 000 | 1 461, 010 | 1, 617, 578 |
| North Carolina | 3, 500 | 3, 000 | 3, 000 | 5, 000 | 3, 500 | 3, 878 | 3, 879 |
| Oregon | 20, 000 | 10, 000 | 5, 000 | 10, 000 | 15, 000 | 38, 787 | 23, 382 |
| South Carolina | 500 | ........ | 500 | 500 | 200 | 232 | 232 |
| Texas | ........ | ........ | 200, 000 | 250, 000 | 300, 000 | 300, 000 | 418, 173 |
| Utah | 6, 800, 000 | 6, 750, 000 | 6, 500, 000 | 7, 000, 000 | 7, 000, 000 | 9, 050, 505 | 9, 057, 014 |
| Virginia | ........ | ........ | ........ | ........ | ........ | ........ | 13 |
| Washington | 1, 000 | 70, 000 | 80, 000 | 100, 000 | 100, 000 | 103, 434 | 36, 801 |
| Other sources, not distributed (*a*) | 5, 000 | 5, 000 | 5, 000 | 500 | 500 | 1, 293 | ........ |
| Latest mint estimate | 48, 800, 000 | 51, 600, 000 | 51, 000, 000 | 53, 350, 000 | 59, 195, 000 | 64, 646, 000 | ........ |

*a* In some years this is stated to include Alabama, Michigan, Tennessee, Texas, Vermont, Virginia, and Wyoming.

The figures for 1866 are taken from the "Report upon the mineral resources of the United States", by Special Commissioners J. Ross Browne and James W. Taylor, published in 1867. The figures for 1867 are from Commissioner J. Ross Browne's report, 1868, and those for 1868 are from the first report by Dr. R. W. Raymond on "Mineral resources of the states and territories west of the Rocky mountains", published in 1869. The figures for the years 1869 to 1875 are from Dr. Raymond's eighth and last report, published in 1876. They are given as estimates made from the best attainable authorities. In many cases he accepts the estimates of Wells, Fargo & Co. as the best attainable, but in other cases he rejects them in favor of figures obtained from other sources.


Gold Production of the leading States.
1877 – 1889.
Estimates of the Director of the Mint.
DOLLARS
20000000
18000000
16000000
14000000
12000000
10000000
8000000
6000000
4000000
2000000
Nevada
California.
Montana.
Colorado.
Nevada.
Dakota.
Idaho.
Oregon.
Arizona.
Alaska.
1877 – 8 – 9 1880 – 1 – 2 – 3 – 4 5 6 7 8 9


Silver Production of the leading States
1877 1889.
U.S. Coining Value.
Estimates of the Director of the Mint.
DOLLARS
28000000
26000000
24000000
22000000
20000000
18000000
16000000
14000000
12000000
10000000
8000000
6000000
4000000
2000000
Nevada.
Colorado.
Montana.
Utah
Nevada.
Idaho.
Arizona.
New Mexico.
California.
1877 8 9 1880 1 2 3 4 5 6 7 8 9

Commissioner Browne, in his report, refers to the statistics for 1866 and earlier years as follows:

> Mr. Swain, superintendent of the branch mint at San Francisco, a gentleman possessing both the means and the disposition to inform himself on this subject, estimates both the products of gold and silver for Oregon, California, Nevada, and Washington territory as follows:

| | |
|---|---|
| 1861 | $43,391,000 |
| 1862 | 49,370,000 |
| 1863 | 52,500,000 |
| 1864 | 63,450,000 |
| 1865 | 70,000,000 |

> Great differences of opinion, however, exist as to the accuracy of this estimate (1866). To some it appears exaggerated, while others pronounce it far below the actual yield. The imperfect returns received for the last 9 months would seem to warrant the conclusion that it is not an unreasonable estimate. For instance, the product of Oregon is assumed to be $8,000,000. Statistical tables supposed to be worthy of credit show a probable yield for that state of $20,000,000. In 1865 the generally accepted estimate for Oregon was $19,000,000, though that was probably above the actual product.

In his report for 1867, Commissioner J. Ross Browne writes as follows concerning the statistics of that year:

> It has been impossible to obtain an account of the shipments from each agency at the express office of Wells, Fargo & Co., at San Francisco. For reasons of private expediency they refrain from giving the desired information. We have, however, the aggregate receipts of their office, and, knowing very nearly what amount can be accredited to California, Nevada, and British Columbia, can draw reasonable conclusions as to the proportion derived from Idaho, Washington, and Oregon. * * *
>
> The bullion product of Washington is estimated by the surveyor general at $1,500,000; that of Oregon is rated as high as $2,500,000. Intelligent residents of Idaho and Montana represent that the figures given in the above estimate, so far as these territories are concerned, are entirely too low, and might be doubled without exceeding the truth. The product of Idaho alone for this year is said to be from $15,000,000 to $18,000,000; that of Montana is estimated by the surveyor general at $20,000,000. Similar exceptions are taken to the estimates of Colorado, New Mexico, and Arizona. As I have no grounds for accepting these statements beyond the assertion that most of the bullion is carried away in the pockets of the miners, I am inclined to rely upon the returns of the assessors, express companies, and official tables of export. Admitting that a fraction over 7 per cent may have escaped notice, although reasonable allowance is made for this in the estimate of $70,000,000, and that a considerable sum may be derived from sources not enumerated, I feel confident the additional allowance of $5,000,000 is sufficient to cover the entire bullion product of the United States for the year 1867, thus making the aggregate from all sources $75,000,000, as stated in the report of the Secretary of the Treasury.
>
> I have endeavored to obtain returns of the annual product of each state and territory since 1848; but, for the reasons already stated, and in the absence of reliable statistics, it has been impossible to make the necessary divisions with more than approximate accuracy.

Dr. Raymond's statistics ending in 1875, there was no attempt made to estimate the production of gold and silver in the United States in 1876, and the only figures given in any official report for that year are those found in the following extract from the report of the director of the mint for the fiscal year ended June 30, 1876:

> From the most authentic sources of information which could be procured it has been estimated that the production of gold and silver for the fiscal year (1876) was about $85,250,000, of which amount $46,750,000 was gold and $38,500,000 silver.

In the table printed in the report of the director of the mint for 1889 these figures are changed to $39,900,000 gold and $38,800,000 silver, a total of $78,700,000.

In his report for the fiscal year ended June 30, 1887, page 14, the mint director estimates the product of the mines for the fiscal year at $44,000,000 gold and $38,000,000 silver, a total of $82,000,000. For the calendar year 1877 the product is given in the same report, page 13, as $45,100,000 gold and $38,950,000 silver, distributed among the states and territories as shown in the accompanying table in the report. In this table the figures for 1877, 1878, and 1879 are from the annual reports of the director of the mint, and for the years 1880 to 1889, inclusive, they are from the "Annual reports of the director of the mint upon the statistics of production of the precious metals in the United States", the last named series of reports beginning in 1880.

The act making appropriations for the sundry civil expenses of the government for the year 1881 contained an appropriation of $5,000 "for the collection of statistics relative to the annual production of the precious metals in the United States, to be expended under the direction of the Secretary of the Treasury". This work was assigned by the Secretary of the Treasury to the director of the mint, whose first report was for the calendar year 1880. Appropriations by acts of Congress for subsequent years have expressly provided that the collection of statistics of the production of the precious metals shall be under the direction of the director of the mint. The results of such collection have been published each year since 1880 in volumes entitled "Production of gold and silver in the United States".

The director of the mint, notwithstanding the very limited appropriation allowed for the purpose, has been able, by utilizing the exceptional facilities which his office affords, to obtain a closer approximation to the actual amount of gold and silver production in the United States than it would be possible to obtain by any method other than a complete census. In this work the director has availed himself of the records of the operations of the several mints and assay offices, of returns from private refineries, from the bankers and brokers dealing in gold and silver, and from express and other transportation companies. Special agents of the mint have also been employed in mining districts where no other facilities could be provided for collecting this class of statistics.

The following extracts from the report of the director of the mint for 1889 show his estimates for that calendar year, together with a statement of the general method he adopts in reaching the results:

PRODUCTION OF GOLD.—The product of gold from our own mines is susceptible of very accurate determination, for the reason that, with the exception of the small amount which enters directly into consumption as jewelry, the entire product finds its way very promptly to the institutions of the mint service, either in crude bullion directly from the mines and mills or in the shape of fine gold bars, the output of private refineries in the United States.

The mints of the United States offer complete facilities to the producers of gold to realize promptly the full value of their product. At the large acid refineries connected with them the base metals are eliminated and the precious metals are parted and refined at an expense to the producer of only the actual cost to the government of the operations. The coinage of gold is free—no charge to depositors—while the manufacture of fine bars bearing the attestation of the government as to weight and fineness is made at a trifling cost. The establishment of government assay offices in gold-producing sections of the country, at which the full mint value is paid depositors of gold bullion immediately upon the determination by chemical test of the quantity of the precious metals contained in their deposits (the government paying the cost of transportation to the mint at Philadelphia for coinage), naturally tends to attract to them the gold produced in those localities. * * *

From an examination of all the returns and data at the disposal of this bureau the product of gold from the mines of the United States during the calendar year 1889 is estimated to have been 1,587,000 fine ounces, of the value of $32,800,000.

The following statement exhibits the data upon which the estimate of the gold product is based:

ESTIMATE OF THE GOLD PRODUCT OF THE UNITED STATES FOR 1889 BY THE DIRECTOR OF THE MINT.

| | FINE OUNCES. |
|---|---|
| Bullion of domestic production deposited at mints and assay offices | 1,546,019 |
| Bullion of domestic production (other than United States mint or assay office bars) exported from the United States | 54,012 |
| Bullion of domestic production reported by 26 private refineries in the United States as having been made into bars for manufacturers and jewelers | 50,009 |
| Total | 1,650,040 |
| Deduct foreign bullion reported by private refineries in the United States, as contained in their product of fine gold bars deposited at mints and assay offices and there classified as of domestic production | 63,811 |
| Domestic product for 1889 | 1,586,229 |

As confirmatory of the foregoing estimate of the gold product of the United States, the following tables for the same year, based upon the work of private and government refineries, is presented:

ESTIMATE OF THE GOLD PRODUCT OF THE MINES IN THE UNITED STATES FOR 1889.

| | FINE OUNCES. |
|---|---|
| Domestic product of fine gold bars reported by 5 private refineries in the United States, being all who manufacture fine gold bars | 847,865 |
| Unrefined gold of domestic production deposited at mints and assay offices | 689,658 |
| Gold of domestic production reported by private works in the United States as having been made into bars for maufacturers and jewelers | 50,009 |
| Domestic product | 1,587,532 |

The domestic product of gold as exhibited in the above estimate was 1,587,532 fine ounces, of the value of $32,817,190.

As a mean between these two estimates, the product has been placed at 1,587,000 fine ounces, of the value of $32,800,000.

Doubtless some slight product may have escaped the researches of this bureau. It is a well-known fact that many gold nuggets and curious specimens of native gold, as well as much gold quartz, mined in the United States are annually made into articles of jewelry and ornamentation. As the value of the product so used is not a matter of record, and, moreover, adds nothing to the supply for monetary purposes, no allowance, by way of estimate, has been made for it.

PRODUCTION OF SILVER.—The product of silver from the mines of the United States is not susceptible of as accurate determination as the product of gold. As the mints of the United States are not open to the free coinage of silver, as of gold, the product of our mines which finds its way to government institutions consists of Treasury purchases of silver for the mandatory coinage of the silver dollar, silver parted from deposits of gold, and silver deposited for manufacture into fine bars with government stamp as to weight and purity. Moreover, government refineries do not offer the same advantages to producers of silver as private works, for the reason that no allowance is made at the former for the value of the base metals contained in deposits, while at private works many of the base metals commonly associated with silver in nature, such as lead and copper, are paid for, and constitute a very important and valuable component. Indeed, it may be said that considerably more than one-half of all the silver produced is extracted from lead ores, while very many copper ores contain appreciable quantities of silver, which is extracted at a profit.

The difficulty, however, in ascertaining the exact product of silver from our own mines does not lie so much in the complex nature of silver ores as it does in the separation from our own product of the silver contained in foreign ores and base bullion reduced and refined in the United States.

Aside from silver bars shipped to the United States for refining, the great mass of the silver imported into this country is contained in silver-lead ores, valuable for fluxing purposes, carrying a large percentage of metallic lead and small quantities of silver to the ton. These foreign products, which began to come to the United States, principally from Mexico, in 1885, have, since the extension of railways into Mexico, largely increased in quantity. To ascertain the quantity of silver extracted from these products is exceedingly difficult, and the effort to do so has entailed considerable labor on this bureau and has taxed to the utmost the courtesy of managers and officers of private refineries in this country.

Another fruitful source of difficulty lies in the different values given to silver, occasioned largely by the fluctuations in the commercial price. As the value only, and not the quantity, of silver imported and exported is registered at the customhouses, the quantity actually brought into and taken out of the country must be somewhat uncertain. Any estimate of the product of silver from our own mines, as distinguished from the product of our smelting and refining works, is at the best but a close approximation.

All the reports and data in the possession of this bureau indicate that the product of silver from our mines for the calendar year 1889 was approximately 50,000,000 fine ounces, of the commercial value, at the average price of silver during the calendar year ($0.935 per ounce fine), of $46,750,000, and of the coining value in silver dollars of $64,646,464.

The following statement presents the data upon which the estimate of the silver product of the country is based:

ESTIMATE OF THE SILVER PRODUCT OF THE UNITED STATES IN 1889 BY THE DIRECTOR OF THE MINT.

| | | FINE OUNCES. |
|---|---|---|
| Bullion deposited at mints and assay offices, classified as of domestic production | | 30,109,325 |
| Bullion (other than United States mint or assay office bars), classified as of domestic production, exported from the United States (customhouse rating at commercial value $26,301,754, corresponding, at average price of silver during the year, $0.935 per fine ounce) | | 28,130,000 |
| Contained in copper matte and ore exported from the United States, silver contents not registered (approximate) | | 629,000 |
| Bullion of domestic production reported by private refineries in the United States as having been made into bars for industrial use | | 2,918,929 |
| Total | | 61,787,254 |
| Deduct: | FINE OUNCES. | |
| Foreign silver bullion imported into the United States (approximate) | 5,833,000 | |
| Silver in ores imported into the United States (approximate) | 7,000,000 | |
| Total imported | 12,833,000 | |
| Less foreign silver bullion deposited at mints and assay offices | 926,558 | |
| Foreign silver included in fine bars manufactured by private refineries in the United States and classified at the mints and customhouse as domestic (approximate) | | 11,906,442 |
| Estimated silver product for 1889 | | 49,880,812 |

As confirmatory of the above estimate of the silver yield of our mines, the following table, exhibiting the product of private and government refineries, together with the silver exported in furnace products, is here presented:

ESTIMATE OF THE SILVER PRODUCT OF THE UNITED STATES IN 1889.

| | FINE OUNCES. |
|---|---|
| Domestic product of fine silver bars reported by 10 private refineries of the United States, being all who manufacture fine silver bars | 47,864,982 |
| Unrefined silver of domestic production deposited at mints and assay offices | 2,024,700 |
| Silver exported in copper matte and ore | 629,000 |
| Estimated silver product for 1889 | 50,518,682 |

As the separation of the product of our own mines from that of foreign ores made by private refineries is not exact, something of a mean between these two estimates has been adopted as approximately representing the silver product of the United States during the calendar year, viz, 50,000,000 fine ounces.

The smelting and refining companies which made confidential returns to the director of the mint for 1889 courteously furnished these same returns to the Census Office. A tabulation from these of the production of fine gold and silver bars gives the same total figures as those given by the director of the mint.

This method is probably correct as regards the gold production, since, as stated by the director of the mint, practically all the gold finds its way to the mints and United States assay offices, and, as shown in the tables previously quoted, two independent methods of computing the total gold production give results which practically agree, differing only by 1,303 ounces. In the case of silver, however, not only the difficulties described by the director of the mint, but the fact that the two estimates made by independent methods give materially different results, indicate the possibility of both methods being quite inaccurate.

A tabulation of the returns of silver production by the refineries which produce both fine and base bullion, after all deductions have been made for the production from foreign ores, and for duplication by one establishment refining the base bullion of another (data for these deductions having been given by all the works), gives a total silver product of 50,996,055 fine ounces of silver bullion, to which should be added 629,000 ounces, reported to the director of the mint as exported in copper matte, making a total of 51,625,055 ounces, or over 1,000,000 ounces greater than the larger of the estimates given in the two tables of the director of the mint previously quoted. No greater weight, however, can be given to this figure than to the estimate of the director of the mint, for it is quite possible that it contains some duplications for which deductions were not made, and, on the other hand, the census investigation has found a number of errors of omission in these statistics, such, for example, as the item of silver exported in copper matte, given by the mint report at 629,000 ounces, while the unquestionably correct returns made to the census show that no less than 1,418,000 ounces of silver were exported in copper matte in 1889.

Another independent estimate is the sum reported to the director of the mint by the mint officers and agents for individual states and territories. This sum is, for gold 1,689,166 ounces, and for silver 56,452,025 ounces. The director of the mint, however, properly gives very little credit to these estimates by agents in the different states on account of the tendency to exaggeration on the part of producers who make returns to the mint agents.

The last independent estimate of the gold and silver production is that made by Mr. Valentine, vice president and general manager of the Wells-Fargo Express Company, based upon the returns of express agents and transportation companies. Converting his figures into ounces, they are as follows: gold, 1,573,526 fine ounces; silver, 68,945,359 fine ounces. This does not include the product of the states of the Appalachian range, nor of Michigan, which the director of the mint estimates at 18,962 ounces of gold and 64,540 ounces of silver.

The annual estimates of Mr. Valentine are widely published and quoted by statisticians, as, for example, by Sir Hector Hay in the tables furnished by him to the royal commission of Great Britain on recent changes in the relative value of the precious metals. In the report of that commission (first part, page 13) he says:

> I think he (Mr. Valentine) is likely to be more correct than the mint figures for this reason: that when the mint authorities send round to the different mines to ascertain how much they have produced it is to the interest of those mining companies to exaggerate their production a little, whereas when they send their bullion by Messrs. Wells, Fargo & Co. all the different mines would declare the actual values. The mining companies would not wish to pay freight on more than the actual value, and, on the other hand, they would not like to declare a less sum, because they are insured in the same way.

Sir Hector Hay's reason for preferring Mr. Valentine's estimates to those of the director of the mint disappear, however, when the former gives the larger figures, as he does for 1889.

In the report on production of precious metals for the year 1886 the director of the mint refers to Mr. Valentine's figures as follows:

> It is interesting to compare the production as here shown with the estimate of Mr. John J. Valentine, of Wells, Fargo & Co. This statistical contribution is based on the carrying trade of the country, their own and that of other express companies, railways, and other conveyances.
>
> It will be readily understood that estimates like Mr. Valentine's are for many reasons necessarily imperfect. Certain express companies are no longer carriers, as formerly, of the entire shipments of gold and silver. A large portion of the deposits at the mints and assay offices of the United States, especially the western institutions, is brought thither by hand or private conveyance, or else delivered by express companies having no relations with the Wells-Fargo company, and often in such form that the value can not be ascertained.
>
> Besides, as more fully stated in my last report of this series, the classification as between gold and silver products in Mr. Valentine's statement is necessarily imperfect, from the fact that a large portion of the silver bullion by express carries gold, and a large portion of the gold dust and bullion by express carries silver. Any division, therefore, as to the amount of gold and silver actually contained in bullion carried by express and other conveyances must be more or less arbitrary. The value of each can be known only after the deposit has reached a mint, a United States assay office, or a private refinery, and been assayed.
>
> The classification as between gold and silver is, in Mr. Valentine's statement, imperfect, not from any fault on the part of the compiler, but as necessarily follows from the character of his returns, as admitted by Mr. Valentine. Under date of the 15th of December, 1886, in a letter to this bureau, this gentleman frankly says:
>
> > Without going into details. I may say that the government report now more nearly approximates the actual output than ours does by reason of the necessarily hurried conclusion of our statement at the close of the year. When we began these statements Wells, Fargo & Co. furnished the only information obtainable.
>
> And in a subsequent letter, dated January 20, Mr. Valentine remarks:
>
> > As stated in a previous letter. I deem your fiscal reports for the United States of America more nearly correct than ours, you having more time and better opportunities to sift local reports than we now enjoy.

The above extract is conclusive as to the weight of probability which should be attached to Mr. Valentine's estimates.

The several estimates thus made by independent authorities are summarized as follows:

ESTIMATES OF PRODUCTION OF GOLD AND SILVER IN THE UNITED STATES IN 1889.

[Fine ounces.]

| AUTHORITIES. | Gold. | Silver. |
|---|---|---|
| Mr. John J. Valentine's estimate | 1,573,526 | 68,945,359 |
| Estimate by officers and agents of mint | 1,689,166 | 56,452,025 |
| Estimate by the director of the mint | 1,587,000 | 50,000,000 |
| Returns from smelting and refining works | | 51,625,055 |
| Report of the Eleventh Census | 1,590,869 | 51,354,851 |

## DISTRIBUTION OF THE PRODUCT AMONG THE STATES.

In each annual report of the director of the mint an attempt is made to distribute the estimated total production of gold and silver in the United States among the several states and territories. The means relied upon for making this distribution are stated as follows in the report for the year 1886:

> It will be understood that the distribution of the product of the country among the states and territories is a matter of secondary importance, and that its correctness is only approximate. The information made use of for this purpose consists mainly of statements furnished by depositors of unrefined gold and silver at the United States mints and assay offices of the sources of the production of their bullion, reports to this bureau by the large private refineries as to the sources of their output, and reports by express and railroad companies handling bullion and ores in the course of transportation. All such reports are checked by, and compared with, the estimates prepared by the mint officers and by other agents of this bureau selected to compile the statistics of the production of the precious metals in the various states and territories.
>
> Estimates made by mint officers and agents of the production of the states and territories assigned to them have never been accepted by this bureau as conclusive, for the following reasons:
>
> First. That the aggregate production of gold and silver in the United States is ascertained from other and what is considered better sources of information, namely, the record of the mint service itself. Information so supplied is always verified by the disposition of

> the product indicated to the bureau by the mints, customhouses, private refineries, and banks. A given product having been ascertained and accounted for, a corresponding quantity only can be distributed among the states and territories of the Union.
>
> Second. As any one familiar with such matters is aware, there is a tendency to exaggerate upon the part of interested or sanguine persons engaged in mining not only as to the value, but as to the character and product of their properties.
>
> Third. From the fact that local agents designated by this bureau are residents of the sections on which they report, and as such particularly selected, it is perhaps warrantable to suppose, as indeed it has sometimes been recognized, that the benefit of a doubt as between a greater or less production reasonably inures to their own divisions of the work. This remark is made without derogation of the quality of the work at the hands of such agents or of the spirit in which such work is undertaken.
>
> Errors of the personal equation in such work rarely fail to go to the credit of the mineral resources of any given section of the country in question.

In the report for 1889 the director writes as follows concerning the estimates of mint officers and agents:

> It has never been the practice to adopt the estimates of the agents for particular localities as correctly representing the product of such sections. However valuable these statistics may be as exhibiting in detail the product of particular mines or sections of the country and the condition of the mining industry in the various states, and however conscientiously the officers and agents selected may have performed the duties intrusted to them, the tendency to exaggeration on the part of individual producers is so great and the sources of information in many cases are so imperfect as to preclude the possibility of accepting, in all cases, the aggregate products reported as the product of the United States.
>
> As has been explained, the gold product of the United States finds its way almost entirely, either directly or indirectly, to the mints of the United States for coinage purposes or for manufacture into bars, so that the total gold product of the country is readily ascertained and accounted for. The silver product of our mines is, owing to the large influx of foreign ores, much more difficult to ascertain than that of gold. The estimate we make of that product is based on what is considered more reliable data than the unverified statements of producers of crude bullion, or estimates made by parties living in and interested in the silver-producing districts.

Concerning the assistance given by private refineries and smelting works to enable the director of the mint to make his estimates of the product of the several states and territories, the same report says:

> The bureau is greatly indebted to the officers and managers of the large private refineries and smelting works in the United States, as well as to their New York agents, for complete and valuable statistics in regard to the output of the precious metals from their works during the year and the sources from which the ores and base bullion were obtained. Without the co-operation of private works it would be exceedingly difficult, indeed well-nigh impossible, to have ascertained accurately the product of the precious metals in this country, for the reason that these works handle more than half of the gold and fully nine-tenths of the silver from our mines, together with all the foreign silver ores which come to this country for reduction.
>
> Through the information furnished by smelting and reduction works turning out base silver bars the bureau has been able to trace the product of private refineries producing bars of fine gold and fine silver to the original source of production.
>
> The reports received from these refineries are treated as confidential, and the information furnished is used mainly in assisting the bureau to verify the estimates of its own agents as to the production of the several states and territories, and as an additional aid in checking the total product of the United States based on deposits at government institutions and exports of the precious metals.

The following tables from the report for 1889 give the distribution of the gold and silver product, the first table being the estimate by the mint officers and agents in the states and territories, which estimate the director does not accept as correct, and the second the director's own estimate, based upon all the sources of information at his command:

AGGREGATE PRODUCT OF GOLD AND SILVER REPORTED BY MINT OFFICERS AND AGENTS FOR THE STATES AND TERRITORIES IN 1889.

| STATES AND TERRITORIES. | Total value. | GOLD. | | SILVER. | |
|---|---|---|---|---|---|
| | | Fine ounces. | Value. | Fine ounces. | Coining value. |
| Total | $107, 906, 543 | 1, 689, 166 | $34, 918, 173 | 56, 452, 025 | $72, 988, 370 |
| Alaska | 963, 250 | 46, 077 | 952, 490 | 8, 322 | 10, 760 |
| Arizona | 3, 811, 904 | 52, 828 | 1, 092, 059 | 2. 103, 630 | 2, 719, 845 |
| California | 14, 852, 533 | 666, 958 | 13, 787, 252 | 823, 928 | 1, 065, 281 |
| Colorado | 30, 195. 275 | 175, 902 | 3. 636, 217 | 20, 541. 770 | 26, 559, 058 |
| Georgia | 108, 070 | 5, 205 | 107, 605 | 360 | 465 |
| Idaho | 6, 496, 055 | 99, 445 | 2, 055, 708 | 3, 434, 331 | 4, 440, 347 |
| Montana | 23, 832, 871 | 183, 535 | 3. 794, 000 | 15, 498. 814 | 20, 038, 871 |
| Nevada | 9, 547. 522 | 154, 156 | 3, 186, 667 | 4, 919, 724 | 6. 360. 855 |
| New Mexico | 3, 027, 425 | 54, 969 | 1, 136, 320 | 1, 462, 651 | 1, 891. 105 |
| North Carolina | 150, 173 | 7. 077 | 146, 295 | 3, 000 | 3, 878 |
| Oregon | 1, 393, 838 | 65, 415 | 1, 352, 249 | 32, 166 | 41, 589 |
| South Carolina | 47, 084 | 2, 266 | 46, 852 | 180 | 232 |
| South Dakota | 3, 073, 288 | 140, 898 | 2, 912, 625 | 124, 263 | 160, 663 |
| Texas | 400, 709 | .............. | .............. | 310, 007 | 400, 709 |
| Utah | 9, 702, 725 | 24, 866 | 514, 025 | 7, 106, 885 | 9, 188, 700 |
| Virginia | 4, 112 | 198 | 4. 100 | 10 | 12 |
| Washington | 299, 709 | 9, 371 | 193, 709 | 81, 984 | 106, 000 |

APPROXIMATE DISTRIBUTION, BY PRODUCING STATES AND TERRITORIES, OF THE PRODUCT OF GOLD AND SILVER IN 1889, AS ESTIMATED BY THE DIRECTOR OF THE MINT.

| STATES AND TERRITORIES. | Total value. | GOLD. | | SILVER. | |
|---|---|---|---|---|---|
| | | Fine ounces. | Value. | Fine ounces. | Coining value. |
| Total | $97, 735, 730 | 1, 594, 775 | $32, 967, 000 | 50, 094, 571 | $64, 768, 730 |
| Alaska | 910, 343 | 43, 537 | 900, 000 | 8, 000 | 10, 343 |
| Arizona | 2, 839, 393 | 43, 537 | 900, 000 | 1, 500, 000 | 1, 939, 393 |
| California | 14, 034, 343 | 628, 875 | 13, 000, 000 | 800, 000 | 1, 034, 343 |
| Colorado | 24, 186, 868 | 169, 312 | 3, 500, 000 | 16, 000, 000 | 20, 686, 868 |
| Georgia | 107, 465 | 5, 176 | 107, 000 | 360 | 465 |
| Idaho | 6, 395, 959 | 96, 750 | 2, 000, 000 | 3, 400, 000 | 4, 395, 959 |
| Michigan | 147, 575 | 3, 386 | 70, 000 | 60, 000 | 77, 575 |
| Montana | 22, 893, 939 | 169, 312 | 3, 500, 000 | 15, 000, 000 | 19, 393, 939 |
| Nevada | 9, 206, 060 | 145, 125 | 3, 000, 000 | 4, 800, 000 | 6, 206, 060 |
| New Mexico | 2, 461, 010 | 48, 375 | 1, 000, 000 | 1, 130, 000 | 1, 461, 010 |
| North Carolina | 148, 878 | 7, 014 | 145, 000 | 3, 000 | 3, 878 |
| Oregon | 1, 238, 787 | 58, 050 | 1, 200, 000 | 30, 000 | 38, 787 |
| South Carolina | 45, 232 | 2, 177 | 45, 000 | 180 | 232 |
| South Dakota | 2, 964, 646 | 140, 287 | 2, 900, 000 | 50, 000 | 64, 646 |
| Texas | 300, 000 | | | 232, 031 | 300, 000 |
| Utah | 9, 550, 505 | 24, 187 | 500, 000 | 7, 000, 000 | 9, 050, 505 |
| Washington | 278, 434 | 8, 466 | 175, 000 | 80, 000 | 103, 434 |
| Alabama, Maryland, Tennessee, Virginia, Vermont, and Wyoming. | 26, 293 | 1, 209 | 25, 000 | 1, 000 | 1, 293 |

The returns from smelting and refining works producing fine or base silver bullion, which were originally made to the director of the mint, have, as already stated, been furnished to the Census Office. By compiling these returns and subtracting all apparent duplications of product through the shipment of base bullion from one establishment to another for refining, another independent estimate is reached, which differs considerably from that of the director of the mint. It is included in the condensed table given hereafter.

Another estimate may be made by adding to the production of fine gold and silver bullion reported by the private refineries the amount of unrefined metal deposited in the mints and United States assay offices as given in the mint director's report. As the latter amounts are given in standard ounces, nine-tenths fine, they require to be converted into fine ounces in making the addition. The results of this method are as follows:

DISTRIBUTION OF THE GOLD PRODUCT IN 1889 (MINT REPORT).

| STATES AND TERRITORIES. | Unrefined gold deposited at mints and assay offices. (Standard ounces.) | Product of private refineries. (Fine ounces.) | Total. (Fine ounces.) |
|---|---|---|---|
| Alabama | 125 | | 113 |
| Alaska | 5, 327 | 14, 640 | 19, 434 |
| Arizona | 15, 851 | 2, 467 | 16, 733 |
| California | 151, 058 | 437, 446 | 573, 398 |
| Colorado | 110, 712 | 92, 033 | 191, 674 |
| Georgia | 4, 962 | | 4, 466 |
| Idaho | 47, 104 | 1 878 | 44, 272 |
| Maryland | 30 | | 27 |
| Michigan | 3, 747 | 810 | 4, 182 |
| Montana | 94, 360 | 41, 484 | 126, 408 |
| Nevada | 72, 509 | 131, 118 | 196, 376 |
| New Hampshire | 26 | | 23 |
| New Mexico | 27, 737 | 1, 209 | 26, 172 |
| North Carolina | 4, 364 | | 3, 928 |
| Oregon | 13, 666 | 1, 650 | 13, 949 |
| South Carolina | 2, 415 | | 2, 174 |
| South Dakota | 151, 405 | 2, 461 | 138, 726 |
| Tennessee | 21 | | 19 |
| Texas | 79 | | 71 |
| Utah | 3, 077 | 14, 874 | 17, 643 |
| Virginia | 140 | | 126 |
| Washington | 1, 796 | 120 | 1, 736 |
| Wyoming | 417 | | 375 |
| Other sources | 55, 359 | | 49, 823 |
| Total unrefined | 766, 287 | | |
| Equal fine ounces | 689, 658 | | |
| Not distributed | | 105, 675 | 105, 675 |
| Total | | 847, 865 | 1, 537, 523 |
| Unrefined | | 689, 658 | |
| Jewelers' bars | | 50, 009 | 50, 009 |
| Total | | 1, 587, 532 | 1, 587, 532 |

### DISTRIBUTION OF THE SILVER PRODUCT IN 1889 (MINT REPORT).

| STATES AND TERRITORIES. | Unrefined silver deposited at mints and assay offices. (Standard ounces.) | Product of private refineries. (Fine ounces.) | Total. (Fine ounces.) |
|---|---|---|---|
| Alabama | 23 | | 21 |
| Alaska | 971 | 900 | 1, 774 |
| Arizona | 23, 712 | 1, 985, 747 | 2, 007, 088 |
| California | 20, 694 | 1, 207, 116 | 1, 225, 741 |
| Colorado | 27, 277 | 19, 160, 706 | 19, 185, 255 |
| Georgia | 336 | | 302 |
| Idaho | 63, 143 | 1, 748, 449 | 1, 805, 278 |
| Maryland | 9 | | 8 |
| Michigan | 62, 978 | 6, 829 | 63, 509 |
| Montana | 294, 038 | 10, 261, 544 | 10, 526, 178 |
| Nevada | 1, 404, 430 | 4, 364, 939 | 5, 628, 926 |
| New Hampshire | 1 | | 1 |
| New Mexico | 132, 516 | 840, 503 | 959, 767 |
| North Carolina | 6, 706 | | 6, 035 |
| Oregon | 2, 430 | 68, 350 | 70, 537 |
| South Carolina | 117 | | 105 |
| South Dakota | 29, 044 | 94, 222 | 120, 362 |
| Tennessee | 1 | | 1 |
| Texas | 2, 338 | 282, 700 | 284, 804 |
| Utah | 13, 656 | 6, 606, 241 | 6, 618, 531 |
| Virginia | 6 | | 5 |
| Washington | 2, 422 | 4, 578 | 6, 758 |
| Wyoming | 49 | | 44 |
| Other sources | 162, 771 | | 146, 494 |
| Total unrefined | 2, 249, 668 | | |
| Equal fine ounces | 2, 024, 700 | | |
| Not distributed | | 1, 232, 158 | 1, 232, 158 |
| Total | | 47, 864, 982 | 49, 889, 682 |
| Unrefined | | 2, 024, 700 | |
| Exported in copper matte | | 629, 000 | 629, 000 |
| Total | | 50, 518, 682 | 50, 518, 682 |

### ESTIMATES OF THE PRODUCTION OF GOLD IN THE UNITED STATES IN 1889 FROM SOURCES OTHER THAN THE CENSUS REPORT.

[Fine ounces.]

| STATES AND TERRITORIES. | Estimates from deposits of unrefined gold at mints and assay offices added to fine bars reported by refineries. | Estimates by J. J. Valentine, states and territories west of the Missouri river. | Estimates by mint officers and special agents. | Estimates by the director of the mint. |
|---|---|---|---|---|
| Total | 1, 587, 532 | 1, 573, 526 | 1, 689, 166 | 1, 594, 775 |
| Alabama | 113 | | | |
| Alaska | 19, 434 | 40, 877 | 46, 077 | 43, 537 |
| Arizona | 16, 733 | 47, 062 | 52, 828 | 43, 537 |
| California | 573, 398 | 499, 667 | 666, 958 | 628, 875 |
| Colorado | 191, 674 | 170, 995 | 175, 902 | 169, 312 |
| Georgia | 4, 466 | | 5, 205 | 5, 176 |
| Idaho | 44, 272 | 155, 018 | 99, 445 | 96, 750 |
| Maryland | 27 | | | |
| Michigan | 4, 182 | | | 3, 386 |
| Montana | 126, 408 | 217, 689 | 183, 535 | 169, 312 |
| Nevada | 196, 376 | 149, 123 | 154, 156 | 145, 125 |
| New Hampshire | 23 | | | |
| New Mexico | 26, 172 | 21, 019 | 54, 969 | 48, 375 |
| North Carolina | 3, 928 | | 7, 077 | 7, 014 |
| Oregon | 13, 949 | 36, 507 | 65, 415 | 58, 050 |
| South Carolina | 2, 174 | | 2, 266 | 2, 177 |
| South Dakota | 138, 726 | 164, 822 | 140, 898 | 140, 287 |
| Tennessee | 19 | | | |
| Texas | 71 | | | |
| Utah | 17, 643 | 739 | 24, 866 | 24, 187 |
| Virginia | 126 | | 198 | |
| Washington | 1, 736 | 6, 386 | 9, 371 | 8, 466 |
| Wyoming | 375 | | | |
| Undistributed | 205, 507 | 63, 622 | | 1, 209 |

### ESTIMATES OF THE PRODUCTION OF SILVER IN THE UNITED STATES IN 1889 FROM SOURCES OTHER THAN THE CENSUS REPORT.

[Fine ounces.]

| STATES AND TERRITORIES | Estimates from deposits of unrefined silver at mints and assay offices added to fine bars reported by refineries. | Estimates from product of fine and base bullion reported by refineries. | Estimates by J. J. Valentine, states and territories west of the Missouri river. | Estimates by mint officers and special agents. | Estimates by the director of the mint. |
|---|---|---|---|---|---|
| Total | 50, 518, 682 | 51, 625, 055 | 68, 945, 359 | 56, 452, 025 | 50, 094, 571 |
| Alabama | 21 | | | | |
| Alaska | 1, 774 | 900 | | 8, 322 | 8, 000 |
| Arizona | 2, 007, 088 | 1, 442, 209 | 650, 708 | 2, 103, 630 | 1, 500, 000 |
| California | 1, 225, 741 | 1, 207, 203 | 706, 890 | 823, 928 | 800, 000 |
| Colorado | 19, 185, 255 | 21, 461, 603 | 20, 576, 433 | 20, 541, 770 | 16, 000, 000 |
| Georgia | 302 | | | 360 | 360 |
| Idaho | 1, 805, 278 | 1, 745, 820 | 8, 047, 340 | 3, 434, 331 | 3, 400, 000 |
| Maryland | 8 | | | | |
| Michigan | 63, 509 | | | | 60, 000 |
| Montana | 10, 526, 178 | 10, 266, 079 | 17, 103, 110 | 15, 498, 814 | 15, 000, 000 |
| Nevada | 5, 628, 926 | 4, 482, 938 | 6, 758, 143 | 4, 919, 724 | 4, 800, 000 |
| New Hampshire | 1 | | | | |
| New Mexico | 959, 767 | 1, 695, 125 | 149, 282 | 1, 462, 651 | 1, 130, 000 |
| North Carolina | 6, 035 | | | 3, 000 | 3, 000 |
| Oregon | 70, 537 | 68, 350 | 32, 662 | 32, 166 | 30, 000 |
| South Carolina | 105 | | | 180 | 180 |
| South Dakota | 120, 362 | 94, 222 | | 124, 263 | 50, 000 |
| Tennessee | 1 | | | | |
| Texas | 284, 804 | 308, 810 | | 310, 007 | 232, 031 |
| Utah | 6, 618, 531 | 6, 849, 547 | 1, 877, 406 | 7, 106, 885 | 7, 000, 000 |
| Virginia | 5 | | | 10 | |
| Washington | 6, 758 | 4, 578 | 90, 425 | 81, 984 | 80, 000 |
| Wyoming | 44 | | | | |
| Not distributed | 1, 378, 652 | 1, 368, 671 | 12, 952, 960 | | 1, 000 |
| Exported in copper matte | 629, 000 | 629, 000 | | | |

The causes of the errors in the mint report are explained by several of the special agents and the director of the mint, who has throughout this investigation extended every courtesy and assistance in his power to the special agent of the census, even furnishing letters of certain mint agents acknowledging and explaining the inaccuracies of their reports. Thus, a mint agent for New Mexico, writing to the director of the mint, says:

> I to-day learned that there has been a considerable discrepancy found in the report made by the census taker and that of myself, especially in the returns of last year, and I have made some effort to account for the same. I can only think that the cause of this is to be found in the fact that men are willing to state what they will not swear to. I inclose a copy of the Silver City Enterprise, in which you will see that a very much larger amount of output is claimed for Grant county than I allowed in the report that I mailed to you yesterday. As stated in my report of yesterday, I have reason to believe that the report of 1889 was too large, and I am sure that it was also for the year preceding it.

Writing to the census, the same agent says:

> I am sure now that my mint report for 1889 was too high, and it simply shows that men are willing to state in a bragging way what they will not swear to. This year I have cut my figures down considerably in my mint report, which has already been mailed. * * * I found out that one mine that is a large producer put out only about half of the amount that I reported and that was given to me by one who certainly knew better, for he was in a position to know; but I know now how it happened: he was trying then to sell the extension to the mine.

One of the most reliable agents for the census, explaining the differences between the census and mint reports for California, says:

> It may be said in general terms that our men visited the mines or owners personally and obtained their information from headquarters, while the mint obtained all its information by answers to circulars, sending no one into the field for information. In a great number of instances they accepted estimates which we were not permitted to do by the scheme by which the census facts were collected. We were obliged to confine ourselves to specified mines and specified questions, ignoring altogether any general information which might have been obtained. We could not accept the estimates of storekeepers and postmasters as to what they thought their camps shipped, but had to confine ourselves to facts and known mines. Hence all the estimates from small mines and from Chinese mines contained in mint reports are absent in ours. Many times in the mint reports these were duplicated. Moreover, the mint reporters themselves found that they were imposed upon by people anxious to give their camps a good name in official reports. We got all the Chinese we could and adopted good measures to obtain their figures. We had letters written in Chinese by the consul telling them to give us the proper reports. The mint took no such precaution, as they could only send circulars, and to those no Chinese responded.
>
> In the matter of hydraulic mines the mint reports may be better than ours, for they may know from their position as recipients of the gold where it came from or can estimate by the camp. In our case, we were in most places received in the same way and the answer was: "Closed by injunctions of United States courts". Of course under these circumstances they could give no information as to product, for it might be used against them by the government, which asked for the information. We tried to overcome this feeling, but it was impossible. I am perfectly certain that our figures are altogether more accurate than those of the mint.

In one county in California the mint gives the same mine under two names, the product of one of these names being $75,000 and the other $18,000. The census agent in that county says that the smaller of these two figures is a large exaggeration, and, moreover, that the mint has made a triplicate report of some of the mines in this county; thus, one item purports to be the yield of the "White river mines", another is the yield of the small mines of White river, and then the mines of White river are given singly. In this way a triplicate report is made of most of the mines of the district. One of the mines of this county was reported to the mint as having produced over $50,000. The mine is reported to the census by the owner as having produced not over $1,200. The agent says further:

> It frequently occurs that mines are relocated, first by one party and then another, and thus have several names, and generally each of these names of a paying mine finds its way to the mint. The department and the mint assume that mining is done by corporations. I do not think there are any paying mines in these 2 counties conducted by any firm which could maintain an action at law, either as a corporation or as a copartnership. 3 companies kept books (as they claimed), but in each case the books were said to be in San Francisco (somewhere). This circumstance of having no legal organization is what causes these "joint companies" to be known by so many names and to be thus duplicated and triplicated by the mint.

Another census agent for California says:

> One difficulty you will find with the mint figures is that the production of a mine is frequently credited to the county from which the gold shipment is made to the mint. Thus La Porte, in Plumas county, gets the credit of gold produced in northern Sierra county; Camptonville, in Yuba county, the credit of the production in a part of Sierra county. Another source of error in the mint figures is that fraudulent, or rather incorrect, statements are willfully made, giving large products to mines that are mere prospects.

A census agent in Colorado writes:

> In most cases the census returns are much more reliable than the mint reports. Two reasons may be given why this should be so. In the first place, parties furnishing information for the census are closely questioned; and, secondly, the law provides a penalty for furnishing false information to census enumerators. On the other hand, information furnished the mint is sent by mail as an act of good nature, and the sender may lie as much as he likes with little risk of exposure.

From the evidence accumulated in the preceding pages it is apparent that the figures published as representing the production of the precious metals in the United States up to recent years have in many cases been mere estimates, sometimes careless and wild, which for the most part have been reduced in subsequent years as their exaggerations became more apparent. It is, indeed, quite probable that even the final figures of years prior to 1880, as published in the last report of the director of the mint, are still much above the actual production of gold and silver, while the published distribution of the production among the states and territories has always been inaccurate.

The Eleventh Census has sought to profit by this experience and to obtain the actual facts as nearly as possible. The reports of the director of the mint, and especially those reports which purport to give the actual production of the individual mines in several of the states, were extremely useful. With sworn confidential returns from the same mines it was easy to ascertain where the mint reports were in error. It was found that a great number of the mines credited in that report with an important output were in fact closed and did not produce anything during the year, and in some cases had not been worked for a number of years. In other cases "Chinese" and "small mines" were credited with considerable amounts, while there were neither Chinese nor small mines in the county. In still other cases the owners of the working mines, knowing that the name and output of the mine would be published in the mint report, gave grossly exaggerated figures, which in the confidential sworn reports made to the census shrunk to much more modest ones.

As a final check on the accuracy of the census report, special agents were sent to the districts where these reports differed materially from the mint reports, and with the figures credited to each mine and to each county as returned to the mint and to the census arranged in parallel columns, they were required to investigate and report on every case of material difference. No reasonable precaution was neglected in order to secure the fullest and most accurate returns possible for this important industry. Absolute accuracy is unattainable for the reasons already given, but it is believed that the statistics given in this report are correct within the limits of reasonable accuracy, and that the distribution of the product among the states and territories is very much more reliable than any statement heretofore made on this subject.

## CENSUS RETURNS OF GOLD AND SILVER PRODUCTION.

Unquestionably the most accurate estimate of the total gold produced is that adopted by the director of the mint and based upon the deposits at the several United States mints and assay offices and at the private refineries. The census report has therefore added to the direct returns obtained from producers such of these deposits as were "unaccounted for" in these returns, which evidently represent the gold exported in ore or matte and the many very small sources of production which it will always be impossible to secure directly.

The total production of gold as given in this report, therefore, is made up of the mint and refinery deposits and of gold exported directly by producers. The distribution of this product among the several states and territories differs in some cases widely from, and is unquestionably much more accurate than, the estimates given in other reports.

The following tables give the production and other statistics of gold and silver as ascertained by the census investigation:

CENSUS STATISTICS OF THE GOLD PRODUCT OF THE MINES IN THE UNITED STATES IN 1889.

| PRODUCT. | Fine ounces. | Value. |
|---|---|---|
| Bullion of domestic production at mint and assay offices | 1,546,019 | $31,959,612 |
| Gold of domestic production (other than United States mint or assay office bars) exported from the United States as bullion or as gold contained in copper matte. | 58,652 | 1,212,444 |
| Bullion of domestic production reported by 26 private refineries in the United States as having been made into bars for manufacturers and jewelers. | 50,009 | 1,033,778 |
| Total | 1,654,680 | 34,205,834 |
| Deduct foreign bullion reported by private refineries in the United States as contained in their product of fine gold bars deposited at mint and assay offices and there classified as of domestic production. | 63,811 | 1,319,090 |
| Domestic product for 1889 | 1,590,869 | 32,886,744 |

This total amount exceeds that which the director of the mint obtained by this method by $86,744, which is the aggregate of two items, one of gold contained in certain copper matte and the other of bullion exported, and which were not included in the mint report. Of this total the census direct returns, including certain estimates made upon the spot by census subagents of the production of mines from which official schedules could not be obtained, amount to $28,638,202, and the excess of gold deposited at mints and private refineries over amount traced to its source amounts to $4,248,542, making a total of $32,886,744.

As shown by the above table, the census investigation has traced directly to the mines which produced it about 87 per cent of the total gold output. In apportioning the gold produced among the states and territories the distribution of this excess of deposits over census returns has necessarily been arbitrary, but in making it consideration has been given to the relative probability of accuracy of the census figures in each state, according to the extent of placer mines in these states, and the likelihood that the direct census returns were more correct in one state than in another. Guided by this consideration, the following distribution of this excess of deposits over the census returns is made, and these figures appear in the summary of each state as "undistributed" gold:

DISTRIBUTION OF UNDISTRIBUTED GOLD, BY STATES AND TERRITORIES.

| | |
|---|---|
| Alaska | $100,000 |
| Arizona | 150,000 |
| California | 2,152,374 |
| Colorado | 100,000 |
| Montana | 846,168 |
| Nevada | 150,000 |
| New Mexico | 100,000 |
| Oregon | 200,000 |
| South Dakota | 200,000 |
| Utah | 100,000 |
| Washington | 150,000 |
| Total | 4,248,542 |

The production of silver is much more easily traced to its source than is that of gold, for the reasons that it is produced in larger quantity, and, being about 20 times as heavy for the same value, is transported through channels more easily followed. The silver produced in the United States goes either to the private refineries, to the mint, or is exported direct in ore, in copper matte, or in base bullion. The total, obtained by aggregating the amounts reported from these channels, corresponds with a surprising degree of closeness to the returns obtained directly from the mines, and is a very convincing proof of the thoroughness of the census investigation and of the accuracy of its returns.

CENSUS REPORT OF THE SILVER PRODUCT OF MINES IN THE UNITED STATES IN 1889.

| PRODUCT. | Fine ounces. | Value at $1.2929 per ounce. |
|---|---|---|
| Domestic product of fine silver bars reported by the 10 private refineries of the United States who manufacture all the fine silver bars. | 47,864,982 | $61,884,635 |
| Unrefined silver of domestic production deposited at mints and assay offices. | 2,024,700 | 2,617,735 |
| Silver exported in base bullion, in copper matte, and in ore (*a*) | 1,506,771 | 1,948,104 |
| Estimated silver product for 1889 | 51,396,453 | 66,450,474 |
| Census direct returns from the mines | 51,354,851 | 66,396,988 |

*a* Of the silver exported, 877,871 ounces which went out in copper matte and in bullion originating in Montana were not included in the mint report.

The following table gives the census returns of the gold and silver production in the United States in 1889, distributed to the states where the metal was mined:

PRODUCTION OF GOLD AND SILVER IN THE CENSUS YEAR 1889, BY STATES AND TERRITORIES. (*a*)

| STATES AND TERRITORIES. | Total value. | GOLD. | | SILVER. | |
|---|---|---|---|---|---|
| | | Fine ounces. | Value. | Fine ounces. | Value. |
| Total | $99, 283, 732 | 1, 590, 869 | $32, 886, 744 | 51, 354, 851 | $66, 396, 988 |
| Alabama | 2, 639 | 123 | 2, 539 | 77 | 100 |
| Alaska | 916, 568 | 43, 762 | 904, 650 | 9, 219 | 11, 918 |
| Arizona | 3, 254, 151 | 44, 029 | 910, 174 | 1, 812, 961 | 2, 343, 977 |
| California | 13, 960, 529 | 608, 882 | 12, 586, 722 | 1, 062, 578 | 1, 373, 807 |
| Colorado | 27, 641, 610 | 187, 881 | 3, 883, 859 | 18, 375, 551 | 23, 757, 751 |
| Georgia | 108, 069 | 5, 204 | 107, 605 | 359 | 464 |
| Idaho | 6, 040, 641 | 95, 983 | 1, 984, 159 | 3, 137, 508 | 4, 056, 482 |
| Maryland | 10, 369 | 501 | 10, 369 | ............ | ............ |
| Michigan | 105, 925 | 4, 210 | 87, 040 | 14, 607 | 18, 885 |
| Montana | $20, 608, 287 | 151, 861 | $3, 139, 327 | 13, 511, 455 | $17, 468, 960 |
| Nevada | 9, 578, 536 | 169, 617 | 3, 506, 295 | 4, 696, 605 | 6, 072, 241 |
| New Mexico | 2, 433, 233 | 39, 457 | 815, 655 | 1, 251, 124 | 1, 617, 578 |
| North Carolina | 150, 674 | 7, 077 | 146, 795 | 3, 000 | 3, 879 |
| Oregon | 987, 691 | 46, 648 | 964, 309 | 17, 851 | 23, 382 |
| South Carolina | 47, 085 | 2, 266 | 46, 853 | 179 | 232 |
| South Dakota | 3, 226, 468 | 149, 533 | 3, 091, 137 | 104, 672 | 135, 331 |
| Texas | 425, 001 | 330 | 6, 828 | 323, 438 | 418, 173 |
| Utah | 9, 544, 680 | 23, 591 | 487, 666 | 7, 005, 193 | 9, 057, 014 |
| Virginia | 4, 113 | 198 | 4, 100 | 10 | 13 |
| Washington | 222, 951 | 9, 005 | 186, 150 | 28, 464 | 36, 801 |
| Wyoming | 14, 512 | 711 | 14, 512 | ............ | ............ |

*a* Computed to the nearest whole ounce.

## DETAILED DISTRIBUTION OF GOLD AND SILVER, BY STATES AND TERRITORIES.

The following table gives the distribution of gold and silver of the territory of Alaska, by mining districts:

GOLD AND SILVER PRODUCTION IN ALASKA TERRITORY.

| DISTRICTS. | Total. | Gold. | Silver. |
|---|---|---|---|
| Total | $916, 568 | $904, 650 | $11, 918 |
| Harris | 684, 768 | 679, 850 | 4, 918 |
| Sheep Creek | 10, 000 | 3, 000 | 7, 000 |
| Silver Bow Basin | 25, 800 | 25, 800 | ............ |
| Yukon | 96, 000 | 96, 000 | ............ |
| Undistributed gold | 100, 000 | 100, 000 | ............ |

The following table gives the gold and silver production of states of the Appalachian range:

GOLD AND SILVER PRODUCTION IN STATES OF THE APPALACHIAN RANGE.

| STATES. | Total. | Gold. | Silver. |
|---|---|---|---|
| Total | $322, 949 | $318, 261 | $4, 688 |
| ALABAMA.—Clay, Cleburne, and Tallapoosa counties, and undistributed petty mining. | 2, 639 | 2, 539 | 100 |
| GEORGIA.—Cherokee, Haralson, McDuffie, Lumpkin, and White counties, and undistributed petty mining (total for state). | 108, 069 | 107, 605 | 464 |
| MARYLAND.—Montgomery county (total for state) | 10, 369 | 10, 369 | ............ |
| NORTH CAROLINA.—Burke, Cabarrus, Clay, Cleveland, Davidson, Franklin, Guilford, Henderson, Mecklenburg, Montgomery, Moore, Randolph, Rowan, Stanly, and Union counties, and undistributed petty mining (total for state). | 150, 674 | 146, 795 | 3, 879 |
| SOUTH CAROLINA.—Chesterfield, Lancaster, Pickens, Union, and York counties, and undistributed petty mining (total for state). | 47, 085 | 46, 853 | 232 |
| VIRGINIA.—Buckingham, Culpeper, Fluvanna, Orange, and Stafford counties, and undistributed petty mining (total for state). | 4, 113 | 4, 100 | 13 |

The following table gives the production of gold and silver by subdivisions of states and territories:

### GOLD AND SILVER PRODUCTION, BY SUBDIVISIONS OF STATES AND TERRITORIES.

#### ARIZONA.

| COUNTIES. | Total. | Gold. | Silver. |
|---|---|---|---|
| Total | $3, 254, 151 | $910, 174 | $2, 343, 977 |
| Cochise | 811, 675 | 62, 370 | 749, 305 |
| Gila | 61, 865 | 240 | 61, 625 |
| Graham | 5, 244 | 684 | 4, 560 |
| Maricopa | 41, 166 | 39, 849 | 1, 317 |
| Mohave | 260, 290 | 42, 799 | 217, 491 |
| Pima | 738, 316 | 57, 306 | 681, 010 |
| Pinal | 194, 135 | 1, 710 | 192, 425 |
| Yavapai | 809, 758 | 454, 921 | 354, 837 |
| Yuma | 181, 702 | 100, 295 | 81, 407 |
| Undistributed gold | 150, 000 | 150, 000 | ............ |

#### CALIFORNIA.

| COUNTIES. | Total. | Gold. | Silver. |
|---|---|---|---|
| Total | 13, 960, 529 | 12, 586, 722 | 1, 373, 807 |
| Amador | 911, 252 | 908, 246 | 3, 006 |
| Butte | 301, 592 | 300, 680 | 912 |
| Calaveras | 736, 881 | 733, 058 | 3, 823 |
| Colusa | 4, 187 | 4, 061 | 126 |
| Del Norte | 17, 400 | 17, 400 | ............ |
| Eldorado | 183, 575 | 183, 210 | 365 |
| Fresno | 207, 523 | 180, 697 | 26, 826 |
| Humboldt | 78, 847 | 78, 709 | 138 |
| Inyo | 148, 025 | 43, 645 | 104, 380 |
| Kern | 60, 750 | 60, 472 | 278 |
| Lassen | 22, 700 | 22, 026 | 674 |
| Los Angeles | 79, 109 | 78, 609 | 500 |
| Mariposa | 20, 052 | 20, 052 | ............ |
| Merced | 100 | 100 | ............ |
| Mono | 206, 398 | 180, 408 | 25, 990 |
| Monterey | 3, 600 | 3, 600 | ............ |
| Napa | 50, 206 | 307 | 49, 899 |
| Nevada | 2, 006, 757 | 1, 967, 649 | 39, 108 |
| Orange | 950 | ............ | 950 |
| Placer | 1, 215, 594 | 1, 211, 209 | 4, 385 |
| Plumas | 499, 430 | 499, 077 | 353 |
| Sacramento | 166, 000 | 166, 000 | ............ |
| San Bernardino | 1, 108, 222 | 2, 821 | 1, 105, 401 |
| San Diego | 251, 073 | 251, 071 | 2 |
| Santa Barbara | 7, 045 | 7, 045 | ............ |
| Shasta | 332, 996 | 328, 964 | 4, 032 |
| Sierra | 1, 329, 192 | 1, 327, 290 | 1, 902 |
| Siskiyou | 808, 198 | 807, 910 | 288 |
| Stanislaus | 15, 955 | 15, 955 | ............ |
| Trinity | 683, 542 | 683, 427 | 115 |
| Tulare | 17, 110 | 17, 109 | 1 |
| Tuolumne | 228, 550 | 228, 337 | 213 |
| Ventura | 6, 831 | 6, 831 | ............ |
| Yuba | 98, 513 | 98, 373 | 140 |
| Undistributed gold | 2, 152, 374 | 2, 152, 374 | ............ |

#### COLORADO.

| COUNTIES. | Total. | Gold. | Silver. |
|---|---|---|---|
| Total | 27, 641, 610 | 3, 883, 859 | 23, 757, 751 |
| Boulder | 417, 782 | 310, 725 | 107, 057 |
| Chaffee | 550, 429 | 260, 627 | 289, 802 |
| Clear Creek | 2, 715, 003 | 372, 400 | 2, 342, 603 |
| Conejos | 6, 213 | 3, 099 | 3, 114 |
| Custer | 58, 904 | 19 | 58, 885 |
| Dolores | 516, 205 | 38, 512 | 477, 693 |
| Eagle | 471, 941 | 121, 654 | 350, 287 |
| Gilpin | 1, 721, 747 | 1, 289, 420 | 432, 327 |
| Gunnison | 205, 882 | 16, 162 | 189, 720 |
| Hinsdale | 21, 969 | 1, 494 | 20, 475 |
| Lake | $8, 467, 151 | $221, 167 | $8, 245, 984 |
| La Plata | 7, 611 | 4, 791 | 2, 820 |
| Ouray | 1, 901, 131 | 236, 309 | 1, 664, 822 |
| Park | 449, 560 | 127, 886 | 321, 674 |
| Pitkin | 7, 362, 422 | 22, 238 | 7, 340, 184 |
| Rio Grande | 10, 891 | 10, 131 | 760 |
| Routt | 18, 400 | 18, 400 | ............ |
| Saguache | 28, 554 | 5, 458 | 23, 096 |
| San Juan | 610, 362 | 142, 687 | 467, 675 |
| San Miguel | 1, 107, 006 | 306, 328 | 800, 678 |
| Summit | 892, 447 | 274, 352 | 618, 095 |
| Undistributed gold | 100, 000 | 100, 000 | ............ |

#### IDAHO.

| COUNTIES. | Total. | Gold. | Silver. |
|---|---|---|---|
| Total | 6, 040, 641 | 1, 984, 159 | 4, 056, 482 |
| Ada | 3, 372 | 3, 307 | 65 |
| Alturas | 479, 815 | 13. 869 | 465, 946 |
| Bingham | 20, 277 | 20, 236 | 41 |
| Boise | 547, 573 | 299, 099 | 248, 474 |
| Cassia | 31, 090 | 12. 671 | 18, 419 |
| Custer | 893, 102 | 164, 475 | 728. 627 |
| Elmore | 341, 148 | 314, 132 | 27, 016 |
| Idaho | 254, 357 | 242, 356 | 12, 001 |
| Kootenai | 28, 500 | 20, 000 | 8, 500 |
| Latah | 1, 000 | 1, 000 | ............ |
| Lemhi | 507, 967 | 377, 868 | 130, 099 |
| Logan | 443, 557 | 24, 107 | 419, 450 |
| Owyhee | 690, 822 | 258, 045 | 432. 777 |
| Shoshone | 1, 779, 734 | 222, 712 | 1, 557, 022 |
| Washington | 18, 327 | 10, 282 | 8, 045 |

#### MICHIGAN.

| COUNTIES. | Total. | Gold. | Silver. |
|---|---|---|---|
| Totai | 105, 925 | 87, 040 | 18, 885 |
| Gogebic and Marquette | 99, 357 | 87, 040 | 12, 317 |
| Houghton and Keweenaw | 6, 568 | ............ | 6, 568 |

#### MONTANA.

| COUNTIES. | Total. | Gold. | Silver. |
|---|---|---|---|
| Total | 20, 608, 287 | 3, 139, 327 | 17, 468, 960 |
| Beaverhead | 904, 656 | 35, 602 | 869, 054 |
| Deerlodge | 6, 346, 230 | 136, 748 | 6, 209, 482 |
| Fergus | 352, 703 | 348, 896 | 3, 807 |
| Jefferson | 1, 709, 599 | 297, 420 | 1, 412, 179 |
| Lewis and Clarke | 1, 707, 642 | 1, 080, 321 | 627, 321 |
| Madison | 12, 435 | 11, 571 | 864 |
| Meagher | 50, 143 | 342 | 49, 801 |
| Missoula | 117. 895 | 4, 750 | 113, 145 |
| Silverbow | 7, 896, 388 | 377, 509 | 7, 518, 879 |
| Undistributed gold | 1, 510, 596 | 846, 168 | 664, 428 |

#### NEVADA.

| COUNTIES. | Total. | Gold. | Silver. |
|---|---|---|---|
| Total | 9, 578, 536 | 3, 506, 295 | 6, 072, 241 |
| Churchill | 28, 250 | 1, 428 | 26, 822 |
| Douglas | 3, 631 | 3, 585 | 46 |
| Elko | 837, 561 | 261, 653 | 575, 908 |
| Esmeralda | 653, 088 | 111, 764 | 541, 324 |
| Eureka | 1, 239, 243 | 178, 946 | 1, 060, 297 |
| Humboldt | 11, 730 | 447 | 11, 283 |
| Lander | 194, 147 | 88, 106 | 106, 041 |
| Lincoln | 158, 326 | 65, 546 | 92, 780 |

## GOLD AND SILVER PRODUCTION, BY SUBDIVISIONS, ETC.—Continued.

### NEVADA—Continued.

| COUNTIES. | Total. | Gold. | Silver. |
|---|---|---|---|
| Lyon | $249,135 | $103,251 | $145,884 |
| Nye | 185,324 | 3,760 | 181,564 |
| Storey | 5,739,049 | 2,510,998 | 3,228,051 |
| Washoe | 11,046 | 10,896 | 150 |
| White Pine | 118,006 | 15,915 | 102,091 |
| Undistributed gold | 150,000 | 150,000 | ............ |

### NEW MEXICO.

| COUNTIES. | Total. | Gold. | Silver. |
|---|---|---|---|
| Total | 2,433,233 | 815,655 | 1,617,578 |
| Bernalillo | 6,740 | 6,740 | ............ |
| Colfax | 23,221 | 23,166 | 55 |
| Donna Ana | 73,025 | ............ | 73,025 |
| Grant | 1,121,237 | 436,025 | 685,212 |
| Lincoln | 55,208 | 52,100 | 3,108 |
| Rio Arriba | 5,340 | 5,240 | 100 |
| Santa Fe | 92,216 | 41,694 | 50,522 |
| Sierra | 844,081 | 135,933 | 708,148 |
| Socorro | 112,165 | 14,757 | 97,408 |
| Undistributed gold | 100,000 | 100,000 | ............ |

### OREGON.

| COUNTIES. | Total. | Gold. | Silver. |
|---|---|---|---|
| Total | 987,691 | 964,309 | 23,382 |
| Baker | 308,719 | 307,097 | 1,622 |
| Coos | 21,327 | 21,327 | ............ |
| Crook | 300 | 300 | ............ |
| Curry | 4,879 | 4,879 | ............ |
| Douglas | 2,500 | 2,500 | ............ |
| Grant | 93,553 | 73,613 | 19,940 |
| Jackson | 31,438 | 31,433 | 5 |
| Josephine | 49,915 | 49,525 | 390 |
| Malheur | 38,350 | 38,350 | ............ |
| Union | 236,710 | 235,285 | 1,425 |
| Undistributed gold | 200,000 | 200,000 | ............ |

### SOUTH DAKOTA.

| COUNTIES. | Total. | Gold. | Silver. |
|---|---|---|---|
| Total | 3,226,468 | 3,091,137 | 135,331 |
| Custer | 3,500 | 3,500 | ............ |
| Lawrence | 2,991,889 | 2,856,558 | 135,331 |

### SOUTH DAKOTA—Continued.

| COUNTIES. | Total. | Gold. | Silver. |
|---|---|---|---|
| Pennington | $31,079 | $31,079 | ............ |
| Undistributed gold | 200,000 | 200,000 | ............ |

### TEXAS.

| COUNTIES. | Total. | Gold. | Silver. |
|---|---|---|---|
| Total | 425,001 | 6,828 | $418,173 |
| El Paso | 89,448 | 6,828 | 82,620 |
| Presidio | 335,553 | ............ | 335,553 |

### UTAH.

| COUNTIES. | Total. | Gold. | Silver. |
|---|---|---|---|
| Total | 9,544,680 | 487,666 | 9,057,014 |
| Beaver | 363,322 | 327 | 362,995 |
| Juab | 3,112,422 | 213,115 | 2,899,307 |
| Piute | 8,995 | 1,395 | 7,600 |
| Salt Lake | 687,263 | 73,887 | 613,376 |
| Summit | 5,029,083 | 88,294 | 4,940,789 |
| Tooele | 124,157 | 10,648 | 113,509 |
| Wasatch | 2,000 | ............ | 2,000 |
| Washington | 117,438 | ............ | 117,438 |
| Undistributed gold | 100,000 | 100,000 | ............ |

### WASHINGTON.

| COUNTIES. | Total. | Gold. | Silver. |
|---|---|---|---|
| Total | 222,951 | 186,150 | 36,801 |
| Asotin | 1,500 | 1,500 | ............ |
| Kittitas | 10,822 | 10,822 | ............ |
| Okanogan | 20,157 | 4,757 | 15,400 |
| Snohomish | 494 | 300 | 194 |
| Stevens | 35,478 | 14,271 | 21,207 |
| Wallawalla | 2,500 | 2,500 | ............ |
| Whitman | 2,000 | 2,000 | ............ |
| Undistributed gold | 150,000 | 150,000 | ............ |

### WYOMING.

| COUNTIES. | Total. | Gold. | Silver. |
|---|---|---|---|
| Total | 14,512 | 14,512 | ............ |
| Albany | 6,172 | 6,172 | ............ |
| Fremont | 8,340 | 8,340 | ............ |

## PER CAPITA PRODUCTION OF GOLD AND SILVER IN 1889.

The per capita production of the precious metals in the several producing states is given in the table following. In Nevada gold and silver production is almost the sole industry of the state, and amounts to $209.3166 per capita, while Montana, Idaho, Colorado, and Arizona follow in this order, the chief occupation of the people being the production of the precious metals.

The average production of gold and silver in the United States amounted in 1889 to $1.5847 per capita of the entire population of the country. In 1880 the per capita production of the precious metals was $1.4842. The production of gold and silver has therefore increased somewhat more rapidly than population in the past 10 years.

### PER CAPITA PRODUCTION OF GOLD AND SILVER, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | Population. | Total production of gold and silver in 1889. | Production of gold and silver per capita. |
|---|---|---|---|
| The United States | 62, 622, 250 | | |
| Alaska | 30, 329 | | |
| Total | 62. 652, 579 | $99, 283, 732 | $1. 5847 |
| Alabama | 1 513, 017 | 2, 639 | 0. 0017 |
| Alaska | 30, 329 | 916, 568 | 30. 2208 |
| Arizona | 59, 620 | 3, 254, 151 | 54. 5815 |
| California | 1, 208, 130 | 13, 960, 529 | 11. 5555 |
| Colorado | 412, 198 | 27, 641, 610 | 67. 0591 |
| Georgia | 1, 837, 353 | 108, 069 | 0. 0588 |
| Idaho | 84, 385 | 6, 040, 641 | 71. 5843 |
| Maryland | 1, 042, 390 | 10, 369 | 0. 0099 |
| Michigan | 2, 093, 889 | $105, 925 | $0. 0506 |
| Montana | 132, 159 | 20, 608, 287 | 155. 9356 |
| Nevada | 45, 761 | 9, 578, 536 | 209. 3166 |
| New Mexico | 153, 593 | 2, 433, 233 | 15. 8421 |
| North Carolina | 1, 617, 947 | 150, 674 | 0. 0931 |
| Oregon | 313, 767 | 987, 691 | 3. 1478 |
| South Carolina | 1, 151, 149 | 47, 085 | 0. 0409 |
| South Dakota | 328, 808 | 3, 226, 468 | 9. 8126 |
| Texas | 2, 235, 523 | 425, 001 | 0. 1901 |
| Utah | 207, 905 | 9, 544, 680 | 45. 9089 |
| Virginia | 1, 655, 980 | 4, 113 | 0. 0025 |
| Washington | 349, 390 | 222, 951 | 0. 6381 |
| Wyoming | 60, 705 | 14, 512 | 0. 2391 |

### STATE AND PER CAPITA PRODUCTION OF GOLD AND SILVER ACCORDING TO RANK.

| Precious metal producing states and territories in order of their value of production. | Total gold and silver production. | Precious metal states and territories in order of their production per capita. | Production of gold and silver per capita. |
|---|---|---|---|
| 1. Colorado | $27, 641, 610 | Nevada | $209. 3166 |
| 2. Montana | 20, 608, 287 | Montana | 155. 9356 |
| 3. California | 13, 960, 529 | Idaho | 71. 5843 |
| 4. Nevada | 9, 578, 536 | Colorado | 67. 0591 |
| 5. Utah | 9, 544, 680 | Arizona | 54. 5815 |
| 6. Idaho | 6, 040, 641 | Utah | 45. 9089 |
| 7. Arizona | 3, 254, 151 | Alaska | 30. 2208 |
| 8. South Dakota | 3, 226, 468 | New Mexico | 15. 8421 |
| 9. New Mexico | 2, 433, 233 | California | 11. 5555 |
| 10. Oregon | 987, 691 | South Dakota | 9. 8126 |
| 11. Alaska | 916, 568 | Oregon | 3. 1478 |
| 12. Texas | $425, 001 | Washington | $0. 6381 |
| 13. Washington | 222, 951 | Wyoming | 0. 2391 |
| 14. North Carolina | 150, 674 | Texas | 0. 1901 |
| 15. Georgia | 108, 069 | North Carolina | 0. 0931 |
| 16. Michigan | 105, 925 | Georgia | 0. 0588 |
| 17. South Carolina | 47, 085 | Michigan | 0. 0506 |
| 18. Wyoming | 14, 512 | South Carolina | 0. 0409 |
| 19. Maryland | 10, 369 | Maryland | 0. 0099 |
| 20. Virginia | 4, 113 | Virginia | 0. 0025 |
| 21. Alabama | 2, 639 | Alabama | 0. 0017 |

The production as given in the report of the Tenth Census is compared in the following tables with the production in 1889 as given in preceding pages. The relative importance of the several states is shown.

### COMPARISON OF BULLION PRODUCTION IN THE CALENDAR YEAR 1889 WITH PRODUCTION IN CENSUS YEAR ENDED MAY 31, 1880.

| STATES AND TERRITORIES. | ELEVENTH CENSUS. | | | TENTH CENSUS. | | |
|---|---|---|---|---|---|---|
| | Total. | Gold. | Silver. | Total. | Gold. | Silver. |
| Total | $99, 283, 732 | $32, 886, 744 | $66, 396, 988 | $74, 490, 620 | $33, 379, 663 | $41, 110, 957 |
| Alabama | 2, 639 | 2, 539 | 100 | 1, 301 | 1, 301 | |
| Alaska | 916, 568 | 904, 650 | 11, 918 | 6, 002 | 5, 951 | 51 |
| Arizona | 3, 254, 151 | 910, 174 | 2, 343, 977 | 2, 537, 790 | 211, 965 | 2, 325, 825 |
| California | 13, 960, 529 | 12, 586, 722 | 1, 373, 807 | 18, 301, 828 | 17, 150, 941 | 1, 150, 887 |
| Colorado | 27, 641, 610 | 3, 883, 859 | 23, 757, 751 | 19, 249, 172 | 2, 699, 898 | 16, 549, 274 |
| Dakota | 3, 226, 468 | 3, 091, 137 | 135, 331 | 3, 376, 656 | 3, 305, 843 | 70, 813 |
| Georgia | 108, 069 | 107, 605 | 464 | 81, 361 | 81, 029 | 332 |
| Idaho | 6, 040, 641 | 1, 984, 159 | 4, 056, 482 | 1, 944, 203 | 1, 479, 653 | 464. 550 |
| Maine | | | | 10, 199 | 2, 999 | 7, 200 |
| Maryland | 10, 369 | 10, 369 | | | | |
| Michigan | 105, 925 | 87, 040 | 18, 885 | 25, 858 | | 25, 858 |
| Montana | 20, 608, 287 | 3, 139, 327 | 17, 468, 960 | 4, 710, 835 | 1, 805, 767 | 2, 905, 068 |
| Nevada | 9, 578, 536 | 3, 506, 295 | 6, 072, 241 | 17, 318, 909 | 4, 888, 242 | 12, 430, 667 |
| New Hampshire | | | | 26, 999 | 10, 999 | 16, 000 |
| New Mexico | 2, 433, 233 | 815, 655 | 1, 617, 578 | 441, 691 | 49, 354 | 392, 337 |
| North Carolina | 150, 674 | 146, 795 | 3, 879 | 119, 093 | 118, 953 | 140 |
| Oregon | 987, 691 | 964, 309 | 23, 382 | 1, 125, 494 | 1, 097, 701 | 27, 793 |
| South Carolina | 47, 085 | 46, 853 | 232 | 13, 096 | 13, 040 | 56 |
| Tennessee | | | | 1, 998 | 1, 998 | |
| Texas | 425, 001 | 6, 828 | 418, 173 | | | |
| Utah | 9, 544, 680 | 487, 666 | 9, 057, 014 | 5, 034, 674 | 291, 587 | 4, 743, 087 |
| Virginia | 4, 113 | 4, 100 | 13 | 9, 321 | 9, 321 | |
| Washington | 222, 951 | 186, 150 | 36, 801 | 136, 819 | 135, 800 | 1, 019 |
| Wyoming | 14, 512 | 14, 512 | | 17, 321 | 17, 321 | |

**The following table gives the percentage of product of the various states and territories:**

PERCENTAGE OF PRODUCT, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | ELEVENTH CENSUS. | | | TENTH CENSUS. | | |
|---|---|---|---|---|---|---|
| | Total. | Gold. | Silver. | Total. | Gold. | Silver. |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Alabama | ........ | 0.01 | ........ | ........ | ........ | ........ |
| Alaska | 0.92 | 2.75 | 0.02 | 0.01 | 0.02 | ........ |
| Arizona | 3.28 | 2.77 | 3.53 | 3.41 | 0.64 | 5.66 |
| California | 14.06 | 38.27 | 2.07 | 24.57 | 51.38 | 2.80 |
| Colorado | 27.84 | 11.81 | 35.78 | 25.84 | 8.09 | 40.25 |
| Dakota | 3.25 | 9.40 | 0.20 | 4.53 | 9.90 | 0.17 |
| Georgia | 0.11 | 0.33 | ........ | 0.11 | 0.24 | ........ |
| Idaho | 6.08 | 6.03 | 6.11 | 2.61 | 4.43 | 1.13 |
| Maine | ........ | ........ | ........ | 0.01 | 0.01 | 0.02 |
| Maryland | 0.01 | 0.03 | ........ | ........ | ........ | ........ |
| Michigan | 0.11 | 0.27 | 0.03 | 0.04 | ........ | 0.06 |
| Montana | 20.76 | 9.55 | 26.31 | 6.33 | 5.41 | 7.07 |
| Nevada | 9.65 | 10.66 | 9.14 | 23.25 | 14.64 | 30.24 |
| New Hampshire | ........ | ........ | ........ | 0.04 | 0.03 | 0.04 |
| New Mexico | 2.45 | 2.48 | 2.44 | 0.59 | 0.15 | 0.95 |
| North Carolina | 0.15 | 0.45 | 0.01 | 0.16 | 0.36 | ........ |
| Oregon | 1.00 | 2.93 | 0.03 | 1.51 | 3.29 | 0.07 |
| South Carolina | 0.05 | 0.14 | ........ | 0.02 | 0.04 | ........ |
| Tennessee | ........ | ........ | ........ | ........ | 0.01 | ........ |
| Texas | 0.43 | 0.02 | 0.63 | ........ | ........ | ........ |
| Utah | 9.61 | 1.48 | 13.64 | 6.76 | 0.87 | 11.54 |
| Virginia | ........ | 0.01 | ........ | 0.01 | 0.03 | ........ |
| Washington | 0.22 | 0.57 | 0.06 | 0.18 | 0.41 | ........ |
| Wyoming | 0.02 | 0.04 | ........ | 0.02 | 0.05 | ........ |

## NOTES ON THE STATISTICAL TABLES.

Relative producing importance of mines.—In the columns showing the relative producing importance of various mines only those mines are considered from which returns were received and which produced bullion, or from which ore was sold and the assay values of such ores appear in the value of the production. Active mines which produced only ore which was not sold or treated in 1889 do not appear in this statement, neither do the figures include small and irregularly worked placer, Chinese, and other diggings not separately listed as mines, and from which no returns could be obtained.

Ore produced.—All ore reported produced in 1889, whether remaining on the dump at the end of the year or not, is included under this head. The returns of "ore produced" and "ore sold" were very imperfect, and the figures in the tables do not therefore represent the output or sales at all accurately.

Ore sold.—This includes no ore remaining on dump or reported as produced in 1889 and sold or treated in 1890, but only the ore reported as sold in 1889, whether mined in 1889 or in earlier years.

Motive power.—The statistics of motive power include only such as were reported on schedules, and therefore do not represent the total amount of motive power actually used. As schedules were received from nearly all the mines that were important enough to require a steam boiler and engine, it is probable that the figures for boilers and engines are nearly correct, but no reliance whatever can be placed on the figures for water wheels, whims, windlasses, and other small motors.

Approximation of labor, wages, and other expenditures and valuations of mines from which full statistics could not be obtained.—In a great number of cases, especially of small mines and placers, it has been impossible to obtain actual figures of the number of men employed, the average number of days worked, the supplies or other expenditures, or the valuation of the mines and machinery. In such cases an approximate estimate of labor and wages has been made by taking these items for the mines from which returns could not be obtained, as bearing the same ratio to the bullion produced by such mines as they do for the mines from which statistics were obtained in the same county, and increasing the total figures of these items for the county by the percentage which the bullion from mines giving imperfect returns bears to the bullion produced by mines giving full returns. Thus, if the total bullion produced by the mines in a certain county which gave full statistics of labor, number of men employed, and wages paid is $100,000, and there is $10,000 worth of bullion produced by mines from which no statistics except the amount of bullion could be obtained, then the total figures of men employed, wages, etc., for those mines which produced the $100,000 are increased by 10 per cent to make the total for the county. As these mines are chiefly small placer mines and diggings, with little or no machinery, no estimate has been placed upon their valuation.

In the cases of the "undistributed gold" for several states, which could not be apportioned to the counties, and of the undistributed gold and silver in Montana, the same plan of estimating the labor, etc., for producing this undistributed gold and silver has been followed, using the total figures for the state as the basis upon which the percentage is calculated. In making these additions the average wages per day and the average number of days worked per year has been taken as the same as that calculated from the returns of mines in the county or state which gives full statistics, increasing the number of men by the percentage found as above described. This is as good a rule as could be adopted in making such estimates; but it is probable that the bullion produced by mines giving imperfect statistics cost the labor of a larger number of men, working shorter time and at lower wages, than a similar amount of bullion produced by mines returning full statistics, for the reason that fully organized mines, which return complete statistics, covering probably four-fifths of the total product, work steadily during the year and pay the highest rates of wages, but employ comparatively few men in proportion to the amount of bullion extracted, while the majority of the small mines and diggings are worked by their owners irregularly, sometimes for only a few days in the year, no actual wages being paid, and the product, which might be called the wages of the operator, amounting to less than the ordinary laborer's wages in the district. In this way a great number of men may be employed to produce a very small result.

In the Pacific states, which include Washington, Oregon, and California, a large amount of the gold product is obtained from irregular workings in ravines and gulches, beds of rivers, etc., of which no definite idea can be obtained as to the amount of wages received by the miners. As a usual thing the wages are just what they manage to get out of the ground. In such instances, for the purpose of this investigation, the wages are computed the same as the product, the rate per day being obtained by prorating the average number of men employed there during the year. The amount that is made in this way varies considerably, and ranges from 50 cents to $4 per day.

In other instances a large portion of the labor is performed by owners of the mines. In such cases, if they worked alone, they were counted as laborers; if employing others, as foremen, the compensation in each instance was computed at the average for the same class in the same county.

COPPER AND LEAD PRODUCED BY MINES LISTED AS GOLD AND SILVER MINES, AND SILVER PRODUCED BY MINES WHOSE CHIEF PRODUCTION IS COPPER AND LEAD.—As many of the gold and silver mines produce also copper and lead, and many copper and lead mines produce gold and silver, it is impossible to exactly apportion the labor, wages, supplies, and other expenditures, and also the valuation of such mines, to the respective metals produced by them. The method adopted in the compilation of the statistics for approximately apportioning the labor and other costs and the valuation is as follows: In cases in which the mine as reported produced chiefly gold or silver, or both, the mine is taken as a precious metal mine, and its complete returns of labor, expenditures, valuation, etc., are taken as belonging entirely to its gold and silver production. In the case of lead and copper mines which produced small quantities of gold and silver, the amount of such gold and silver has been included with the county totals, and an apportionment of the labor, wages, and valuations has been made by taking the proportion which the gold and silver thus included bears to the rest of the bullion produced in the county and adding the percentage accordingly, assuming that the average wages and the average number of days worked in producing this added bullion were the same as the average for the county.

In this manner it is believed that as near an approximation as possible has been made of the amount of labor, wages, etc., expended in the production of gold and silver and of the value of the mines, machinery, etc., utilized in the production of these metals.

## STATISTICS OF GOLD AND SILVER MINES IN THE UNITED STATES IN 1889.

| STATES AND TERRITORIES. | Total value. | PRODUCTION. | | | | EMPLOYÉS ABOVE GROUND. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Gold. | | Silver. | | Average number employed. | | | | Average wages per day. | | | |
| | | Fine ounces. | Value. | Fine ounces. | Coining value. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. |
| Total | $99, 283, 732 | 1, 590, 869 | $32, 886, 744 | 51, 354, 851 | $66, 396, 988 | 1, 585 | 3, 273 | 17, 085 | 82 | $4. 04 | $3. 67 | $2. 51 | $1. 16 |
| Alabama | 2, 639 | 123 | 2, 539 | 77 | 100 | 3 | 3 | 4 | ...... | 3. 00 | 1. 50 | 0. 90 | ...... |
| Alaska | 916, 568 | 43, 762 | 904, 650 | 9, 219 | 11, 918 | 16 | 21 | 158 | ...... | 5. 50 | 5. 00 | 2. 82 | ...... |
| Arizona | 3, 254, 151 | 44, 029 | 910, 174 | 1, 812, 961 | 2, 343, 977 | 64 | 118 | 703 | 2 | 4. 59 | 3. 89 | 2. 46 | 1. 50 |
| California | 13, 960, 529 | 608, 882 | 12, 586, 722 | 1, 062, 578 | 1, 373, 807 | 565 | 660 | 6, 231 | 21 | 3. 30 | 3. 26 | 2. 05 | 1. 29 |
| Colorado | 27, 641, 610 | 187, 881 | 3, 883, 859 | 18, 375, 551 | 23, 757, 751 | 330 | 781 | 1, 505 | 16 | 4. 33 | 3. 80 | 2. 91 | 1. 70 |
| Georgia | 108, 069 | 5, 204 | 107, 605 | 359 | 464 | 22 | 22 | 152 | ...... | 1. 33 | 1. 47 | 0. 92 | ...... |
| Idaho | 6, 040, 641 | 95, 983 | 1, 984, 159 | 3, 137, 508 | 4, 056, 482 | 128 | 354 | 964 | 2 | 4. 64 | 4. 04 | 3. 04 | 1. 25 |
| Maryland | 10, 369 | 501 | 10, 369 | ........... | ........... | 2 | ........ | 50 | ...... | 2. 25 | ........ | 1. 05 | ...... |
| Michigan | 105, 925 | 4, 210 | 87, 040 | 14, 607 | 18, 885 | 2 | 7 | 32 | ...... | 3. 25 | 2. 25 | 1. 81 | ...... |
| Montana | 20, 608, 287 | 151, 861 | 3, 139, 327 | 13, 511, 455 | 17, 468, 960 | 96 | 307 | 2, 613 | 5 | 5. 39 | 4. 14 | 3. 25 | 1. 40 |
| Nevada | 9, 578, 536 | 169, 617 | 3, 506, 295 | 4, 696, 605 | 6, 072, 241 | 83 | 261 | 779 | 1 | 5. 07 | 4. 56 | 3. 22 | 2. 00 |
| New Mexico | 2, 433, 233 | 39, 457 | 815, 655 | 1, 251, 124 | 1, 617, 578 | 45 | 90 | 520 | 13 | 4. 09 | 3. 50 | 2. 31 | 1. 27 |
| North Carolina | 150, 674 | 7, 077 | 146, 795 | 3, 000 | 3, 879 | 21 | 53 | 230 | 16 | 2. 27 | 1. 44 | 0. 88 | 0. 32 |
| Oregon | 987, 691 | 46, 648 | 964, 309 | 17, 851 | 23, 382 | 59 | 132 | 1, 490 | 3 | 3. 32 | 2. 92 | 2. 29 | 0. 83 |
| South Carolina | 47, 085 | 2, 266 | 46, 853 | 179 | 232 | 7 | 13 | 114 | 1 | 3. 02 | 2. 54 | 0. 99 | 0. 50 |
| South Dakota | 3, 226, 468 | 149, 533 | 3, 091, 137 | 104, 672 | 135, 331 | 31 | 260 | 554 | ...... | 4. 57 | 3. 23 | 2. 85 | ...... |
| Texas | 425, 001 | 330 | 6, 828 | 323, 438 | 418, 173 | 7 | 10 | 36 | ...... | 4. 62 | 2. 83 | 2. 07 | ...... |
| Utah | 9, 544, 680 | 23, 591 | 487, 666 | 7, 005, 193 | 9, 057, 014 | 85 | 171 | 475 | 2 | 5. 27 | 3. 93 | 3. 14 | 1. 00 |
| Virginia | 4, 113 | 198 | 4, 100 | 10 | 13 | 2 | ........ | 30 | ...... | 1. 38 | ........ | 1. 00 | ...... |
| Washington | 222, 951 | 9, 005 | 186, 150 | 28, 464 | 36, 801 | 3 | 3 | 394 | ...... | 5. 00 | 4. 00 | 3. 00 | ...... |
| Wyoming | 14, 512 | 711 | 14, 512 | ........... | ........... | 14 | 7 | 51 | ...... | 3. 86 | 3. 07 | 2. 36 | ...... |

| STATES AND TERRITORIES. | EMPLOYÉS ABOVE GROUND—continued. | | | | EMPLOYÉS BELOW GROUND. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number of days worked during year. | | | | Average number employed. | | | | Average wages per day. | | | |
| | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. |
| Total | 216 | 244 | 195 | 199 | 1, 352 | 29, 144 | 3, 870 | 43 | $4. 16 | $3. 12 | $2. 46 | $1. 51 |
| Alabama | 155 | 210 | 150 | ......... | 1 | 7 | 6 | ......... | 3. 00 | 1. 25 | 0. 83 | ......... |
| Alaska | 238 | 305 | 285 | ......... | 9 | 127 | 55 | ......... | 4. 86 | 3. 60 | 2. 00 | ......... |
| Arizona | 219 | 187 | 205 | 145 | 34 | 1, 467 | 132 | 1 | 4. 44 | 3. 17 | 2. 24 | 1. 50 |
| California | 182 | 196 | 147 | 129 | 303 | 5, 522 | 944 | 8 | 3. 49 | 2. 74 | 2. 28 | 1. 50 |
| Colorado | 234 | 254 | 237 | 212 | 396 | 9, 585 | 569 | 14 | 4. 22 | 3. 08 | 2. 88 | 1. 69 |
| Georgia | 173 | 250 | 228 | ......... | 17 | 41 | 93 | ......... | 1. 60 | 1. 05 | 0. 80 | ......... |
| Idaho | 211 | 203 | 187 | 285 | 163 | 2, 566 | 318 | ......... | 4. 79 | 3. 59 | 3. 10 | ......... |
| Maryland | 249 | ......... | 257 | ......... | ......... | 2 | 10 | ......... | ......... | 1. 50 | 1. 25 | ......... |
| Michigan | 312 | 350 | 319 | ......... | 1 | 40 | 13 | ......... | 2. 25 | 2. 00 | 1. 80 | ......... |
| Montana | 286 | 296 | 287 | 300 | 65 | 2, 552 | 254 | 5 | 5. 11 | 3. 48 | 3. 13 | 1. 75 |
| Nevada | 304 | 208 | 270 | 365 | 84 | 2, 003 | 214 | 1 | 4. 83 | 3. 60 | 2. 91 | 1. 50 |
| New Mexico | 169 | 193 | 204 | 166 | 48 | 1, 202 | 154 | 12 | 4. 15 | 3. 15 | 2. 26 | 1. 21 |
| North Carolina | 242 | 193 | 179 | 243 | 18 | 238 | 178 | ......... | 2. 26 | 1. 02 | 0. 85 | ......... |
| Oregon | 140 | 199 | 130 | 240 | 22 | 653 | 57 | 1 | 3. 92 | 3. 16 | 2. 23 | 1. 50 |
| South Carolina | 63 | 113 | 92 | 26 | 2 | 34 | 20 | ......... | 3. 10 | 1. 15 | 0. 90 | ......... |
| South Dakota | 272 | 311 | 204 | ......... | 31 | 645 | 369 | ......... | 4. 75 | 3. 49 | 2. 99 | ......... |
| Texas | 130 | 174 | 147 | ......... | 5 | 78 | 192 | ......... | 2. 60 | 1. 27 | 1. 25 | ......... |
| Utah | 307 | 319 | 311 | 365 | 132 | 2, 065 | 274 | 1 | 4. 21 | 3. 04 | 2. 80 | 1. 50 |
| Virginia | 50 | ......... | 70 | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... | ......... |
| Washington | 221 | 280 | 139 | ......... | 8 | 187 | 7 | ......... | 4. 69 | 3. 43 | 3. 28 | ......... |
| Wyoming | 105 | 56 | 81 | ......... | 13 | 130 | 11 | ......... | 4. 84 | 3. 05 | 2. 36 | ......... |

## STATISTICS OF GOLD AND SILVER MINES IN THE UNITED STATES IN 1889—Continued.

| STATES AND TERRITORIES. | EMPLOYÉS BELOW GROUND—cont'd. | | | | Total number of mines. | Total producing mines reported. | NUMBER OF MINES PRODUCING— | | | | | | | NONPRODUCTIVE MINES. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number of days worked during year. | | | | | | | | | | | | | | |
| | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | | | Less than $1,000. | $1,000 to $10,000. | $10,000 to $50,000. | $50,000 to $100,000. | $100,000 to $250,000. | $250,000 to $500,000. | Over $500,000. | Mines working but nonproductive. | Number of mines idle. |
| Total | 238 | 236 | 244 | 208 | 6,004 | 3,729 | 1,610 | 1,408 | 437 | 95 | 107 | 44 | 28 | 1,009 | 1,266 |
| Alabama | 210 | 165 | 137 | ...... | 3 | 3 | 2 | 1 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Alaska | 360 | 300 | 282 | ...... | 12 | 5 | 2 | 1 | 1 | ........ | ........ | ........ | 1 | 7 | ........ |
| Arizona | 193 | 215 | 199 | 89 | 192 | 154 | 26 | 82 | 34 | 7 | 4 | 1 | ........ | 14 | 24 |
| California | 217 | 209 | 237 | 103 | 2,109 | 1,359 | 627 | 583 | 102 | 18 | 21 | 6 | 2 | 244 | 506 |
| Colorado | 226 | 241 | 244 | 257 | 1,871 | 988 | 426 | 331 | 134 | 27 | 44 | 19 | 7 | 418 | 465 |
| Georgia | 148 | 179 | 212 | ...... | 18 | 15 | 5 | 7 | 3 | ........ | ........ | ........ | ........ | 3 | ........ |
| Idaho | 247 | 204 | 206 | ...... | 536 | 421 | 209 | 147 | 42 | 12 | 8 | 3 | ........ | 69 | 46 |
| Maryland | ........ | 250 | 260 | ...... | 2 | 2 | 1 | 1 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Michigan | 310 | 310 | 310 | ...... | 3 | 2 | ........ | 1 | 1 | ........ | ........ | ........ | ........ | 1 | ........ |
| Montana | 303 | 295 | 292 | 324 | 114 | 75 | 13 | 21 | 13 | 3 | 9 | 8 | 8 | 26 | 13 |
| Nevada | 312 | 289 | 248 | 30 | 245 | 171 | 47 | 69 | 29 | 12 | 9 | 2 | 3 | 44 | 30 |
| New Mexico | 233 | 214 | 228 | 211 | 250 | 129 | 28 | 56 | 34 | 7 | 3 | 1 | ........ | 57 | 64 |
| North Carolina | 197 | 155 | 205 | ...... | 24 | 17 | 4 | 9 | 4 | ........ | ........ | ........ | ........ | 7 | ........ |
| Oregon | 194 | 157 | 200 | 40 | 285 | 200 | 122 | 63 | 13 | 2 | ........ | ........ | ........ | 30 | 55 |
| South Carolina | 73 | 70 | 24 | ...... | 4 | 2 | ........ | 1 | 1 | ........ | ........ | ........ | ........ | 2 | ........ |
| South Dakota | 299 | 293 | 321 | ...... | 48 | 31 | 12 | 6 | 6 | 3 | ........ | 1 | 3 | 8 | 9 |
| Texas | 163 | 175 | 156 | ...... | 10 | 5 | 2 | ........ | ........ | 1 | 2 | ........ | ........ | 1 | 4 |
| Utah | 279 | 273 | 316 | 200 | 129 | 66 | 9 | 21 | 19 | 3 | 7 | 3 | 4 | 26 | 37 |
| Virginia | ........ | ........ | ........ | ...... | 7 | 3 | 3 | ........ | ........ | ........ | ........ | ........ | ........ | 4 | ........ |
| Washington | 124 | 134 | 154 | ...... | 86 | 70 | 65 | 4 | 1 | ........ | ........ | ........ | ........ | 7 | 9 |
| Wyoming | 80 | 58 | 108 | ...... | 56 | 11 | 7 | 4 | ........ | ........ | ........ | ........ | ........ | 41 | 4 |

| STATES AND TERRITORIES. | EXPENDITURES. | | | | | | | | | | VALUE OF MINING PROPERTY. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grand total of expenditures. | Grand total of wages. | Total wages paid in 1889. | Paid to contractors. | Office force. | | | | Value of supplies. | Other expenditures. | Total value of plant. | Value of buildings. | Value of railroads on surface. |
| | | | | | Males. | | Females. | | | | | | |
| | | | | | Number. | Wages paid. | Number. | Wages paid. | | | | | |
| Total | $63,451,136 | $43,180,696 | $40,412,022 | $1,421,301 | 848 | $1,335,189 | 25 | $12,184 | $13,817,739 | $6,452,701 | $465,960,566 | $7,565,918 | $1,475,674 |
| Alabama | 8,042 | 7,588 | 6,363 | ............ | ...... | 1,225 | ...... | .......... | 335 | 119 | 35,000 | 1,400 | 1,050 |
| Alaska | 618,009 | 315,498 | 304,731 | ............ | 4 | 10,767 | ...... | .......... | 301,236 | 1,275 | 4,239,955 | 41,778 | 16,633 |
| Arizona | 2,058,039 | 1,599,259 | 1,499,641 | 48,902 | 30 | 50,716 | ...... | .......... | 348,662 | 110,118 | 19,734,884 | 207,264 | 17,800 |
| California | 12,506,555 | 9,689,265 | 9,191,500 | 296,373 | 160 | 199,955 | 4 | 1,437 | 2,151,229 | 666,061 | 67,641,986 | 1,662,014 | 238,467 |
| Colorado | 13,834,332 | 10,114,682 | 9,339,875 | 400,772 | 219 | 368,639 | 7 | 5,396 | 2,559,705 | 1,159,945 | 137,881,531 | 1,235,853 | 137,562 |
| Georgia | 141,474 | 90,474 | 77,070 | 958 | 16 | 12,446 | ...... | .......... | 18,634 | 32,366 | 1,504,758 | 12,815 | 9,420 |
| Idaho | 4,870,484 | 3,686,362 | 3,331,151 | 194,257 | 104 | 160,261 | 9 | 693 | 889,958 | 294,164 | 44,194,594 | 1,012,677 | 283,183 |
| Maryland | 18,001 | 13,800 | 12,800 | ............ | 1 | 1,000 | ...... | .......... | 2,632 | 1,569 | 370,000 | 1,000 | 685 |
| Michigan | 99,183 | 56,198 | 45,096 | 10,447 | 2 | 655 | ...... | .......... | 9,152 | 33,833 | 676,212 | 11,600 | 87,406 |
| Montana | 9,259,657 | 6,123,132 | 5,881,500 | 120,567 | 52 | 120,815 | 1 | 250 | 2,399,963 | 736,562 | 53,256,396 | 494,619 | 312,150 |
| Nevada | 8,254,755 | 3,764,256 | 3,522,280 | 36,011 | 119 | 203,385 | 1 | 2,580 | 2,329,607 | 2,160,892 | 25,049,695 | 476,331 | 160,524 |
| New Mexico | 1,730,126 | 1,333,462 | 1,226,857 | 55,383 | 30 | 49,454 | 2 | 1,768 | 270,706 | 125,958 | 18,268,499 | 256,349 | 15,000 |
| North Carolina | 285,795 | 195,614 | 153,439 | 13,945 | 27 | 28,230 | ...... | .......... | 64,731 | 25,450 | 2,173,993 | 58,540 | 6,603 |
| Oregon | 1,604,781 | 970,758 | 909,001 | 13,907 | 28 | 47,850 | ...... | .......... | 549,745 | 84,278 | 15,151,203 | 684,004 | 28,626 |
| South Carolina | 79,098 | 37,078 | 33,078 | ............ | 2 | 4,000 | ...... | .......... | 11,052 | 30,968 | 1,148,050 | 15,125 | 12,000 |
| South Dakota | 2,589,383 | 1,742,042 | 1,605,738 | 120,169 | 9 | 16,135 | ...... | .......... | 721,139 | 126,202 | 5,271,110 | 124,775 | 8,087 |
| Texas | 205,808 | 82,586 | 76,146 | 270 | 5 | 6,170 | ...... | .......... | 17,602 | 105,620 | 405,292 | 7,900 | .......... |
| Utah | 4,875,211 | 3,022,648 | 2,869,852 | 105,535 | 33 | 47,261 | ...... | .......... | 1,111,963 | 740,600 | 63,009,466 | 1,229,109 | 138,378 |
| Virginia | 2,875 | 2,400 | 2,100 | ............ | 1 | 300 | ...... | .......... | 175 | 300 | 50,000 | 2,500 | .......... |
| Washington | 328,816 | 282,759 | 277,859 | 2,500 | 1 | 2,400 | ...... | .......... | 35,320 | 10,737 | 3,536,925 | 10,520 | 500 |
| Wyoming | 80,712 | 50,835 | 45,945 | 1,305 | 5 | 3,525 | 1 | 60 | 24,193 | 5,684 | 2,361,017 | 19,745 | 1,600 |

## STATISTICS OF GOLD AND SILVER MINES IN THE UNITED STATES IN 1889—Continued.

| STATES AND TERRITORIES. | VALUE OF MINING PROPERTY—continued. | | | | | VALUE OF MILL OR REDUCTION WORKS. | | | | MOTIVE POWER. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Boilers. | | Engines. | |
| | Machinery. | Underground improvements. | Mine supplies. | Mine proper. | Cash. | Total. | Buildings. | Machinery. | Supplies. | Number. | Horse power. | Number. | Horse power. |
| Total | $14,985,215 | $95,806,648 | $3,919,480 | $338,094,821 | $4,112,810 | $20,362,772 | $5,685,562 | $13,456,938 | $1,220,272 | 2,034 | 78,343 | 1,364 | 55,122 |
| Alabama | 20,465 | 4,353 | 287 | 6,395 | 1,050 | 8,456 | 700 | 6,650 | 1,106 | 1 | 14 | 1 | ... |
| Alaska | 148,067 | 155,343 | 83,000 | 3,778,467 | 16,667 | 556,307 | 53,788 | 465,719 | 36,800 | 2 | 360 | 2 | 300 |
| Arizona | 469,497 | 1,906,560 | 105,370 | 17,018,293 | 10,100 | 828,495 | 198,060 | 585,835 | 44,600 | 88 | 2,563 | 60 | 1,030 |
| California | 4,330,986 | 12,305,794 | 585,431 | 48,248,811 | 270,483 | 3,792,982 | 976,241 | 2,683,856 | 132,885 | 298 | 9,813 | 266 | 8,633 |
| Colorado | 2,961,167 | 26,316,640 | 719,062 | 105,708,422 | 802,825 | 2,432,244 | 690,719 | 1,699,165 | 42,360 | 622 | 23,929 | 502 | 13,972 |
| Georgia | 37.964 | 96,896 | 8,007 | 1,337,376 | 2,280 | 219,411 | 32,540 | 185,222 | 1,649 | 9 | 369 | 7 | 283 |
| Idaho | 928,439 | 8,295,875 | 415,634 | 33,154,216 | 104,570 | 2,540,888 | 760,118 | 1,599,888 | 180,882 | 225 | 5,559 | 80 | 2,296 |
| Maryland | 1,965 | 16,825 | 750 | 348,775 | ... | 5,175 | 1,500 | 3,675 | ... | 2 | 100 | 1 | ... |
| Michigan | 114,007 | 19,100 | 18,690 | 415,000 | 10,409 | ... | ... | ... | ... | 5 | 270 | 7 | 529 |
| Montana | 1,642,241 | 11,352,908 | 546,605 | 38,646,253 | 261,620 | 3,314,577 | 1,179,919 | 1,861,946 | 272,712 | 145 | 8,266 | 86 | 4,239 |
| Nevada | 1,278,072 | 7,445,625 | 348,854 | 15,202,039 | 138,250 | 1,818,176 | 458,881 | 1,187,352 | 171,943 | 189 | 9,283 | 139 | 11,048 |
| New Mexico | 881,045 | 2,413,506 | 312,822 | 14,273,655 | 116,122 | 1,079,910 | 201,540 | 829,150 | 49,220 | 100 | 3,773 | 62 | 1,912 |
| North Carolina | 168,325 | 404,328 | 8,652 | 1,494,026 | 33,519 | 301,414 | 52,334 | 244,271 | 4,809 | 89 | 4,113 | 47 | 2.415 |
| Oregon | 486,403 | 1,524,368 | 93,116 | 12,198,130 | 136,556 | 1,145,006 | 447,993 | 650,188 | 46,825 | 26 | 811 | 16 | 1,796 |
| South Carolina | 18,125 | 67,000 | 4,500 | 1,031,300 | ... | 78,725 | 9,000 | 68,225 | 1,500 | 12 | 595 | 4 | 210 |
| South Dakota | 336,923 | 603,888 | 37,462 | 4,140,827 | 19,148 | 573,774 | 155,402 | 389,068 | 29,304 | 66 | 3,427 | 41 | 2,969 |
| Texas | 9,200 | 25,000 | 4,192 | 357,000 | 2,000 | 49,560 | 10,000 | 20,000 | 19,560 | 2 | 20 | 2 | 66 |
| Utah | 1,013,509 | 22,111,817 | 605,271 | 35,726,352 | 2,185,030 | 1,445,047 | 408,752 | 857,228 | 179,067 | 139 | 4,525 | 24 | 2,829 |
| Virginia | 2,500 | 5,000 | 2,'000 | 38,000 | ... | 7,500 | 2,000 | 5,000 | 500 | 4 | 145 | 3 | 125 |
| Washington | 14,765 | 399,840 | 6,260 | 3,103,040 | 2,000 | 34,550 | 18,650 | 11,900 | 4,000 | 2 | 30 | 2 | 21 |
| Wyoming | 121,550 | 335,982 | 13,515 | 1,868,444 | 181 | 130,575 | 27,425 | 102,600 | 550 | 8 | 378 | 12 | 449 |

| STATES AND TERRITORIES. | MOTIVE POWER—cont'd. | | | Number of animals. | Total value of bullion. | Total capital invested. | Amount of capital per dollar of bullion produced. | Amount of bullion produced per dollar of capital. | Total expenditures. | Value of bullion per dollar of expense. | Amount of expense per dollar of bullion. | Net percentage of apparent profit or loss(—) on total capital. | Average assay value per ton of ore sold. | Average bullion value per ton of ore treated. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Other power. | Motors. | | | | | | | | | | | | |
| | | Number. | Horse power. | | | | | | | | | | | |
| Total | ... | 623 | 18,821 | 3,965 | $99,283,732 | $486,323,338 | $4.90 | $0.20 | $63,451,136 | $1.56 | $0.64 | 7.37 | $45.88 | $13.30 |
| Alabama | ... | ... | ... | 3 | 2,639 | 43,456 | 16.47 | 0.06 | 8,042 | 0.33 | 3.05 | —12.43 | ... | ... |
| Alaska | ... | ... | ... | ... | 916,568 | 4,796,262 | 5.23 | 0.19 | 618,009 | 1.48 | 0.67 | 6.22 | ... | ... |
| Arizona | (*a*) | 2 | 40 | 354 | 3,254,151 | 20,563,379 | 6.32 | 0.16 | 2,058,039 | 1.58 | 0.63 | 5.82 | 113.77 | 34.26 |
| California | (*b*) | 370 | 12,063 | 1,007 | 13,960,529 | 71,434,968 | 5.12 | 0.20 | 12,506,555 | 1.12 | 0.90 | 2.04 | 74.79 | 7.90 |
| Colorado | (*c*) | 34 | 1,253 | 1,109 | 27,641,610 | 140,313,775 | 5.08 | 0.20 | 13,834,332 | 2.00 | 0.50 | 9.84 | 42.86 | 8.95 |
| Georgia | (*d*) | 25 | 20 | 9 | 108,069 | 1,724,169 | 15.95 | 0.06 | 141,474 | 0.76 | 1.31 | — 1.94 | ... | ... |
| Idaho | (*e*) | 67 | 3,274 | 273 | 6,040,641 | 46,735,482 | 7.74 | 0.13 | 4,870,484 | 1.24 | 0.81 | 2.50 | ... | ... |
| Maryland | ... | ... | ... | 3 | 10,369 | 375,175 | 36.18 | 0.03 | 18,001 | 0.58 | 1.74 | — 2.03 | ... | ... |
| Michigan | (*d*) | ... | ... | 6 | 105,925 | 676,212 | 6.38 | 0.16 | 99,183 | 1.07 | 0.94 | 1.00 | ... | 3.32 |
| Montana | (*f*) | 5 | 158 | 265 | 20,608,287 | 56,570,973 | 2.75 | 0.36 | 9,259,657 | 2.23 | 0.45 | 20.06 | 39.98 | 42.31 |
| Nevada | (*g*) | 34 | 705 | 233 | 9,578,536 | 26,867,871 | 2.81 | 0.36 | 8,254,755 | 1.16 | 0.86 | 4.93 | 128.34 | 21.76 |
| New Mexico | (*h*) | ... | ... | 200 | 2,433,233 | 19,348,409 | 7.95 | 0.13 | 1,730,126 | 1.41 | 0.71 | 3.63 | 35.21 | 15.98 |
| North Carolina | ... | 14 | 399 | 42 | 150,674 | 2,475,407 | 16.43 | 0.06 | 285,795 | 0.53 | 1.90 | — 5.46 | ... | ... |
| Oregon | (*i*) | 34 | 339 | 126 | 987,691 | 16,296,209 | 16.50 | 0.06 | 1,604,781 | 0.62 | 1.62 | — 3.79 | 88.19 | 11.20 |
| South Carolina | ... | ... | ... | 7 | 47,085 | 1,226,775 | 26.05 | 0.04 | 79,098 | 0.60 | 1.68 | — 2.61 | ... | ... |
| South Dakota | (*d*) | ... | ... | 71 | 3,226,468 | 5,844,884 | 1.81 | 0.55 | 2,589,383 | 1.25 | 0.80 | 10.90 | 47.79 | 3.01 |
| Texas | (*j*) | 6 | ... | 31 | 425,001 | 454,852 | 1.07 | 0.93 | 205,808 | 2.07 | 0.48 | 48.19 | 69.49 | 32.14 |
| Utah | (*k*) | 13 | 419 | 166 | 9,544,680 | 64,454,513 | 6.75 | 0.15 | 4,875,211 | 1.96 | 0.51 | 7.24 | 54.22 | 34.67 |
| Virginia | ... | ... | ... | 2 | 4,113 | 57,500 | 13.98 | 0.07 | 2,875 | 1.43 | 0.70 | 2.15 | ... | ... |
| Washington | (*l*) | 12 | 81 | 19 | 222,951 | 3,571,475 | 16.02 | 0.06 | 328,816 | 0.68 | 1.47 | — 2.96 | 707.17 | 13.48 |
| Wyoming | (*m*) | 7 | 70 | 39 | 14,512 | 2,491,592 | 171.69 | 0.01 | 80,712 | 0.18 | 5.56 | — 2.66 | ... | 14.99 |

*a* Windlasses and whims, 49.
*b* Water windlasses, etc., 439.
*c* Water, etc., 266.
*d* Water.
*e* Water windlasses, etc.
*f* Water whims, etc., 18.
*g* Water whims, etc., 50.
*h* Whims, windlasses.
*i* Water, etc., 40.
*j* Windlass.
*k* Whims, etc.
*l* Water windlass and whims.
*m* Waterwheels, whims, and windlass.

## STATISTICS OF GOLD AND SILVER IN THE STATES OF THE APPALACHIAN RANGE.

| STATES. | Ore produced. (Tons.) | Ore sold or treated. (Tons.) | BULLION PRODUCED FROM ORE SOLD OR TREATED IN 1889. | | EMPLOYÉS ABOVE GROUND. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | |
| | | | Gold. (Value.) | Silver. (Value.) | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. |
| **ALABAMA.** | | | | | | | | | | | | | | | | |
| Clay, Cleburne, and Tallapoosa counties, and undistributed petty mining. | 470 | 470 | $2,539 | $100 | 3 | 3 | 4 | ...... | $3.00 | $1.50 | $0.90 | ...... | 155 | 210 | 150 | ...... |
| GEORGIA | 90,694 | 78,134 | 107,605 | 464 | 22 | 22 | 152 | ...... | 1.33 | 1.47 | 0.92 | ...... | 173 | 250 | 228 | ...... |
| Cherokee, Haralson, and McDuffie counties. | 2,817 | 2,817 | 18,160 | 5 | 1 | 11 | 25 | ...... | 1.33 | 1.50 | 1.05 | ...... | 160 | 276 | 230 | ...... |
| Lumpkin county | 42,450 | 34,450 | 27,132 | 282 | 9 | 3 | 35 | ...... | 1.30 | 1.38 | 0.90 | ...... | 117 | 154 | 143 | ...... |
| White county | 12,500 | 12,500 | 23,318 | ...... | 4 | ...... | 37 | ...... | 1.40 | ...... | 0.86 | ...... | 303 | ...... | 306 | ...... |
| Undistributed petty mining | 32,927 | 28,367 | 38,995 | 177 | 8 | 8 | 55 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| **MARYLAND.** | | | | | | | | | | | | | | | | |
| Montgomery county | 1,150 | 1,150 | 10,369 | ...... | 2 | ...... | 50 | ...... | 2.25 | ...... | 1.05 | ...... | 249 | ...... | 257 | ...... |
| NORTH CAROLINA | 20,581 | 18,821 | 146,795 | 3,879 | 21 | 53 | 230 | 16 | 2.27 | 1.44 | 0.88 | $0.32 | 242 | 193 | 179 | 243 |
| Cabarrus county | 1,200 | ...... | 15,500 | ...... | 1 | 1 | 8 | ...... | 2.80 | 1.35 | 0.90 | ...... | 312 | 240 | 288 | ...... |
| Mecklenburg county | 520 | 60 | 1,583 | 20 | 2 | 5 | 13 | ...... | 2.40 | 1.25 | 0.94 | ...... | 188 | 192 | 110 | ...... |
| Montgomery county | 8,054 | 7,954 | 24,518 | 406 | 4 | 10 | 32 | ...... | 1.75 | 1.62 | 0.91 | ...... | 300 | 152 | 213 | ...... |
| Clay, Cleveland, Franklin, Moore, Randolph, Rowan, Stanly, and Union counties. | 9,807 | 9,807 | 58,953 | 962 | 7 | 21 | 102 | 12 | 2.49 | 1.39 | 0.86 | 0.32 | 236 | 220 | 171 | 243 |
| Davidson, Guilford, and Henderson counties. | 1,000 | 1,000 | 733 | ...... | 1 | 2 | 13 | ...... | 2.00 | 1.50 | 0.85 | ...... | 90 | 100 | 156 | ...... |
| Undistributed petty mining | ...... | ...... | 45,558 | 2,491 | 6 | 14 | 62 | 4 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| SOUTH CAROLINA | 10,250 | 10,250 | 46,853 | 232 | 7 | 13 | 114 | 1 | 3.02 | 2.54 | 0.99 | 0.50 | 65 | 113 | 92 | 26 |
| Chesterfield, Lancaster, Pickens, Union, and York counties. | 10,250 | 10,250 | 42,273 | ...... | 7 | 13 | 64 | 1 | 3.02 | 2.54 | 0.99 | 0.50 | 65 | 113 | 92 | 26 |
| Undistributed petty mining | ...... | ...... | 4,580 | 232 | ...... | ...... | 50 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| **VIRGINIA.** | | | | | | | | | | | | | | | | |
| Buckingham, Culpeper, Fluvanna, Orange, and Stafford counties, and undistributed petty mining. | 600 | 600 | 4,100 | 13 | 2 | ...... | 30 | ...... | 1.38 | ...... | 1.00 | ...... | 50 | ...... | 70 | ...... |

STATISTICS OF GOLD AND SILVER IN THE STATES OF THE APPALACHIAN RANGE—Continued.

| STATES. | EMPLOYÉS BELOW GROUND. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | |
| | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. |
| **ALABAMA.** | | | | | | | | | | | | |
| Clay, Cleburne, and Tallapoosa counties, and undistributed petty mining. | 1 | 7 | 6 | ........... | $3.00 | $1.25 | $0.83 | ........... | 210 | 165 | 137 | ........... |
| **GEORGIA** | 17 | 41 | 93 | ........... | 1.60 | 1.05 | 0.80 | ........... | 148 | 179 | 212 | ........... |
| Cherokee, Haralson, and McDuffie counties. | 4 | 11 | 7 | ........... | 2.30 | 1.20 | 0.82 | ........... | 200 | 200 | 200 | ........... |
| Lumpkin county | 7 | 8 | 32 | ........... | 1.20 | 0.85 | 0.80 | ........... | 118 | 150 | 100 | ........... |
| White county | ........... | ........... | 20 | ........... | ........... | ........... | 0.80 | ........... | ........... | ........... | 300 | ........... |
| Undistributed petty mining | 6 | 22 | 34 | ........... | ........... | ........... | ........... | ........... | ........... | ........... | ........... | ........... |
| **MARYLAND.** | | | | | | | | | | | | |
| Montgomery county | ........... | 2 | 10 | ........... | ........... | 1.50 | 1.25 | ........... | ........... | 250 | 200 | ........... |
| **NORTH CAROLINA** | 18 | 238 | 178 | ........... | 2.26 | 1.02 | 0.85 | ........... | 197 | 155 | 205 | ........... |
| Cabarrus county | 1 | 10 | 6 | ........... | 2.50 | 1.10 | 0.90 | ........... | 312 | 216 | 216 | ........... |
| Mecklenburg county | 2 | 34 | 10 | ........... | 2.00 | 1.24 | 0.92 | ........... | 104 | 134 | 175 | ........... |
| Montgomery county | 5 | 66 | 36 | ........... | 2.50 | 0.86 | 0.80 | ........... | 201 | 140 | 279 | ........... |
| Clay, Cleveland, Franklin, Moore, Randolph, Rowan Stanly, and Union counties. | 5 | 63 | 69 | ........... | 2.07 | 1.04 | 0.84 | ........... | 208 | 174 | 185 | ........... |
| Davidson, Guilford, and Henderson counties. | ........... | 1 | 9 | ........... | ........... | 1.50 | 1.00 | ........... | ........... | 90 | 90 | ........... |
| Undistributed petty mining | 5 | 64 | 48 | ........... | ........... | ........... | ........... | ........... | ........... | ........... | ........... | ........... |
| **SOUTH CAROLINA** | 2 | 34 | 20 | ........... | 3.10 | 1.15 | 0.90 | ........... | 73 | 70 | 24 | ........... |
| Chesterfield, Lancaster, Pickens, Union, and York counties. | 2 | 34 | 20 | ........... | 3.10 | 1.15 | 0.90 | ........... | 73 | 70 | 24 | ........... |
| Undistributed petty mining | ........... | ........... | ........... | ........... | ........... | ........... | ........... | ........... | ........... | ........... | ........... | ........... |
| **VIRGINIA.** | | | | | | | | | | | | |
| Buckingham, Culpeper, Fluvanna, Orange, and Stafford counties, and undistributed petty mining. | ........... | ........... | ........... | ........... | ........... | ........... | ........... | ........... | ........... | ........... | ........... | ........... |

## STATISTICS OF GOLD AND SILVER IN THE STATES OF THE APPALACHIAN RANGE—Continued.

| STATES. | Total producing mines reported. | NUMBER OF MINES PRODUCING— |  |  | Mines working but nonproductive. | EXPENDITURES. |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |  |  | Office force. |  |  |  |
|  |  |  |  |  |  |  |  |  |  | Males. |  | Females. |  |
|  |  | Less than $1,000. | $1,000 to $10,000. | $10,000 to $50,000. |  | Grand total of expenditures. | Grand total of wages. | Total wages paid in 1889. | Paid to contractors. | Number. | Wages paid. | Number. | Wages paid. |
| ALABAMA. |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Clay, Cleburne, and Tallapoosa counties, and undistributed petty mining. | 3 | 2 | 1 | ........ | ........ | $8,042 | $7,588 | $6,363 | ........ | ........ | $1,225 | ........ | ........ |
| GEORGIA | 15 | 5 | 7 | 3 | 3 | 141,474 | 90,474 | 77,070 | $958 | 16 | 12,446 | ........ | ........ |
| Cherokee, Haralson, and McDuffie counties. | 3 | 1 | 1 | 1 | ........ | 49,680 | 26,129 | 22,001 | ........ | 6 | 4,128 | ........ | ........ |
| Lumpkin county | 9 | 4 | 4 | 1 | 2 | 20,241 | 14,218 | 12,408 | 310 | 1 | 1,500 | ........ | ........ |
| White county | 3 | ........ | 2 | 1 | 1 | 20,190 | 17,280 | 14,680 | 300 | [illegible] | 2,300 | ........ | ........ |
| Undistributed petty mining | ........ | ........ | ........ | ........ | ........ | 51,363 | 32,847 | 27,981 | 348 | 6 | 4,518 | ........ | ........ |
| MARYLAND. |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Montgomery county | 2 | 1 | 1 | ........ | ........ | 18,001 | 13,800 | 12,800 | ........ | 1 | 1,000 | ........ | ........ |
| NORTH CAROLINA | 17 | 4 | 9 | 4 | 7 | 285,795 | 195,614 | 153,439 | 13,945 | 27 | 28,230 | ........ | ........ |
| Cabarrus county | 2 | 1 | ........ | 1 | ........ | 13,950 | 8,000 | 8,000 | ........ | ........ | ........ | ........ | ........ |
| Mecklenburg county | 3 | 2 | 1 | ........ | ........ | 21,385 | 14,116 | 11,766 | ........ | 3 | 2,350 | ........ | ........ |
| Montgomery county | 4 | ........ | 3 | 1 | ........ | 66,267 | 44,523 | 26,745 | 6,923 | 6 | 10,855 | ........ | ........ |
| Clay, Cleveland, Franklin, Moore, Randolph, Rowan, Stanly, and Union counties. | 8 | 1 | 5 | 2 | 3 | 102,662 | 72,365 | 64,208 | 3,256 | 9 | 4,901 | ........ | ........ |
| Davidson, Guilford, and Henderson counties. | ........ | ........ | ........ | ........ | 4 | 4,343 | 3,780 | 1,280 | ........ | 2 | 2,500 | ........ | ........ |
| Undistributed petty mining | ........ | ........ | ........ | ........ | ........ | 77,185 | 52,830 | 41,440 | 3,766 | 7 | 7,624 | ........ | ........ |
| SOUTH CAROLINA | 2 | ........ | 1 | 1 | 2 | 79,098 | 37,078 | 33,078 | ........ | 2 | 4,000 | ........ | ........ |
| Chesterfield, Lancaster, Pickens, Union, and York counties. | 1 | ........ | ........ | 1 | 2 | 74,348 | 32,524 | 28,524 | ........ | 2 | 4,000 | ........ | ........ |
| Undistributed petty mining | 1 | ........ | 1 | ........ | ........ | 4,750 | 4,554 | 4,554 | ........ | ........ | ........ | ........ | ........ |
| VIRGINIA. |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Buckingham, Culpeper, Fluvanna, Orange, and Stafford counties, and undistributed petty mining. | 3 | 3 | ........ | ........ | 4 | 2,875 | 2,400 | 2,100 | ........ | 1 | 300 | ........ | ........ |

STATISTICS OF GOLD AND SILVER IN THE STATES OF THE APPALACHIAN RANGE—Continued.

| STATES. | EXPENDITURES—continued. |  | VALUE OF MINING PROPERTY. |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|
|  | Value of supplies. | Other expenditures. | Total value of plant. | Value of buildings. | Value of of railroads on surface. | Machinery. | Underground improvements. | Mine supplies. | Mine proper. | Cash. |
| **ALABAMA.** |  |  |  |  |  |  |  |  |  |  |
| Clay, Cleburne, and Tallapoosa counties, and undistributed petty mining. | $335 | $119 | $35,000 | $1,400 | $1,050 | $20,465 | $4,353 | $287 | $6,395 | $1,050 |
| GEORGIA | 18,634 | 32,366 | 1,504,758 | 12,815 | 9,420 | 37,964 | 96,896 | 8,007 | 1,337,376 | 2,280 |
| Cherokee, Haralson, and McDuffie counties. | 4,279 | 19,272 | 210,951 | 5,119 | 1,000 | 14,831 | 59,217 | 5,000 | 124,332 | 1,452 |
| Lumpkin county | 5,090 | 933 | 307,500 | 2,100 | ........ | 9,350 | 2,500 | 100 | 293,450 | ........ |
| White county | 2,500 | 410 | 440,000 | 950 | 5,000 | ........ | ........ | ........ | 434,050 | ........ |
| Undistributed petty mining | 6,765 | 11,751 | 546,307 | 4,646 | 3,420 | 13,783 | 35,179 | 2,907 | 485,544 | 828 |
| **MARYLAND.** |  |  |  |  |  |  |  |  |  |  |
| Montgomery county | 2,632 | 1,569 | 370,000 | 1,000 | 685 | 1,965 | 16,825 | 750 | 348,775 | ........ |
| NORTH CAROLINA | 64,731 | 25,450 | 2,173,993 | 58,540 | 6,603 | 168,325 | 404,328 | 8,652 | 1,494,026 | 33,519 |
| Cabarrus county | 4,000 | 1,950 | 17,000 | 5,000 | ........ | 2,000 | ........ | ........ | 10,000 | ........ |
| Mecklenburg county | 5,562 | 1,707 | 132,800 | 1,875 | 540 | 8,700 | 55,400 | 400 | 65,285 | 600 |
| Montgomery county | 11,426 | 10,318 | 330,390 | 11,555 | 1,480 | 51,740 | 64,830 | 2,365 | 198,420 | ........ |
| Clay, Cleveland, Franklin, Moore, Randolph, Rowan, Stanly, and Union counties. | 25,841 | 4,456 | 861,666 | 15,300 | 2,500 | 38,825 | 132,400 | 3,200 | 645,575 | 23,866 |
| Davidson, Guilford, and Henderson counties. | 420 | 146 | 245,000 | 9,000 | 300 | 21,600 | 42,500 | 350 | 171,250 | ........ |
| Undistributed petty mining | 17,482 | 6,873 | 587,137 | 15,810 | 1,783 | 45,460 | 109,198 | 2,337 | 403,496 | 9,053 |
| SOUTH CAROLINA | 11,052 | 30,968 | 1,148,050 | 15,125 | 12,000 | 18,125 | 67,000 | 4,500 | 1,031,300 | ........ |
| Chesterfield, Lancaster, Pickens, Union, and York counties. | 10,856 | 30,968 | 1,148,050 | 15,125 | 12,000 | 18,125 | 67,000 | 4,500 | 1,031,300 | ........ |
| Undistributed petty mining | 196 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| **VIRGINIA.** |  |  |  |  |  |  |  |  |  |  |
| Buckingham, Culpeper, Fluvanna, Orange, and Stafford counties, and undistributed petty mining. | 175 | 300 | 50,000 | 2,500 | ........ | 2,500 | 5,000 | 2,000 | 38,000 | ........ |

STATISTICS OF GOLD AND SILVER IN THE STATES OF THE APPALACHIAN RANGE—Continued.

| STATES. | VALUE OF MILL OR REDUCTION WORKS. | | | | MOTIVE POWER. | | | | | | | Number of animals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | Buildings. | Machinery. | Supplies. | Boilers. | | Engines. | | Other power. | Motors. | | |
| | | | | | Number. | Horse power. | Number. | Horse power. | | Number. | Horse power. | |
| **ALABAMA.** | | | | | | | | | | | | |
| Clay, Cleburne, and Tallapoosa counties, and undistributed petty mining. | $8,456 | $700 | $6,650 | $1,106 | 1 | 14 | 1 | ........ | ........ | ........ | ........ | 2 |
| **GEORGIA** | 219,411 | 32,540 | 185,222 | 1,649 | 9 | 369 | 7 | 283 | ........ | 25 | 20 | 9 |
| Cherokee, Haralson, and McDuffie counties. | 48,152 | 15,876 | 31,776 | 500 | 4 | 155 | 5 | 100 | Water ...... | 2 | 20 | 9 |
| Lumpkin county | 78,600 | 3,950 | 74,200 | 450 | 2 | 80 | 2 | 80 | Water ...... | 14 | ........ | ........ |
| White county | 13,000 | 900 | 12,000 | 100 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Undistributed petty mining | 79,659 | 11,814 | 67,246 | 599 | 3 | 134 | ........ | 103 | ........ | 9 | ........ | ........ |
| **MARYLAND.** | | | | | | | | | | | | |
| Montgomery county | 5,175 | 1,500 | 3,675 | ........ | 2 | 100 | 1 | ........ | ........ | ........ | ........ | 3 |
| **NORTH CAROLINA** | 301,414 | 52,334 | 244,271 | 4,809 | 89 | 4,113 | 47 | 2,415 | ........ | 14 | 399 | 42 |
| Cabarrus county | 3,000 | ........ | 3,000 | ........ | 3 | 140 | ........ | ........ | ........ | ........ | ........ | ........ |
| Mecklenburg county | 11,800 | 300 | 11,250 | 250 | 7 | 202 | 5 | 190 | ........ | ........ | ........ | ........ |
| Montgomery county | 68,260 | 12,200 | 55,400 | 660 | 18 | 918 | 2 | 272 | ........ | ........ | ........ | 18 |
| Clay, Cleveland, Franklin, Moore, Randolph, Rowan, Stanly, and Union counties. | 54,450 | 12,200 | 40,150 | 2,100 | 29 | 1,327 | 22 | 1,121 | ........ | 9 | 256 | 13 |
| Davidson, Guilford, and Henderson counties. | 82,500 | 13,500 | 68,500 | 500 | 8 | 415 | 5 | 180 | ........ | 1 | 35 | ........ |
| Undistributed petty mining | 81,404 | 14,134 | 65,971 | 1,299 | 24 | 1,111 | 13 | 652 | ........ | 4 | 108 | 11 |
| **SOUTH CAROLINA** | 78,725 | 9,000 | 68,225 | 1,500 | 12 | 595 | 4 | 210 | ........ | ........ | ........ | 7 |
| Chesterfield, Lancaster, Pickens, Union, and York counties. | 78,725 | 9,000 | 68,225 | 1,500 | 12 | 595 | 4 | 210 | ........ | ........ | ........ | 7 |
| Undistributed petty mining | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| **VIRGINIA.** | | | | | | | | | | | | |
| Buckingham, Culpeper, Fluvanna, Orange, and Stafford counties, and undistributed petty mining. | 7,500 | 2,000 | 5,000 | 500 | 4 | 145 | 3 | 125 | ........ | ........ | ........ | 2 |

## GOLD AND SILVER STATISTICS OF ALASKA.

| MINING DISTRICTS, ETC. | Ore produced. (Tons.) | Ore sold or treated. (Tons.) | BULLION PRODUCED FROM ORE SOLD OR TREATED IN 1889. | | EMPLOYÉS ABOVE GROUND. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | |
| | | | Gold. (Value.) | Silver. (Value.) | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. |
| **Total** | 218, 232 | 216, 612 | $904, 650 | $11, 918 | 16 | 21 | 158 | ...... | $5. 50 | $5. 00 | $2. 82 | ...... | 238 | 305 | 285 | ...... |
| **Harris** | 218, 232 | 216, 612 | 679, 850 | 4, 918 | 12 | 16 | 118 | ...... | 5. 50 | 5. 00 | 2. 82 | ...... | 238 | 305 | 285 | ...... |
| **Sheep Creek** | ........ | ........ | 3, 000 | 7, 000 | 4 | 5 | 40 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| **Silver Bow Basin placer** | ........ | ........ | 25, 800 | ........ | | | | | | | | | | | | |
| **Yukon Union and Yukon placers.** | ........ | ........ | 96, 000 | ........ | | | | | | | | | | | | |
| **Undistributed gold** | ........ | ........ | 100, 000 | ........ | | | | | | | | | | | | |

| MINING DISTRICTS, ETC. | EMPLOYÉS BELOW GROUND. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | |
| | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. |
| **Total** | 9 | 127 | 55 | .......... | $4. 86 | $3. 60 | $2. 00 | .......... | 360 | 300 | 282 | ........ |
| **Harris** | 7 | 95 | 41 | .......... | 4. 86 | 3. 60 | 2. 00 | .......... | 360 | 300 | 282 | ........ |
| **Sheep Creek** | 2 | 32 | 14 | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | ........ |
| **Silver Bow Basin placer** | | | | | | | | | | | | |
| **Yukon Union and Yukon placers.** | | | | | | | | | | | | |
| **Undistributed gold** | | | | | | | | | | | | |

| MINING DISTRICTS, ETC. | Total producing mines reported. | NUMBER OF MINES PRODUCING— | | | | Mines working but nonproductive. | Total number reported. | EXPENDITURES. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Office force. (Males.) | | | |
| | | Less than $1,000. | $1, 000 to $10,000. | $10,000 to $50,000. | Over $50,000. | | | Grand total of expenditures. | Grand total of wages. | Total wages paid in 1889. | Number. | Wages paid. | Value of supplies. | Other expenditures. |
| **Total** | 5 | 2 | 1 | 1 | 1 | 7 | 12 | $618, 009 | $315, 498 | $304, 731 | 4 | $10, 767 | $301, 236 | $1, 275 |
| **Harris** | 5 | 2 | 1 | 1 | 1 | 7 | 12 | 463, 506 | 236, 623 | 228, 548 | 3 | 8, 075 | 225, 927 | 956 |
| **Sheep Creek** | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 154, 503 | 78, 875 | 76, 183 | 1 | 2, 692 | 75, 309 | 319 |
| **Silver Bow Basin placer** | | | | | | | | | | | | | | |
| **Yukon Union and Yukon placers.** | | | | | | | | | | | | | | |
| **Undistributed gold** | | | | | | | | | | | | | | |

| MINING DISTRICTS, ETC. | VALUE OF MINING PROPERTY. | | | | | | | | VALUE OF MILL OR REDUCTION WORKS. | | | | MOTIVE POWER. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | Boilers. | | Engines. | |
| | Total value of plant. | Value of buildings. | Value of railroads on surface. | Machinery. | Underground improvements. | Mine supplies. | Mine proper. | Cash. | Total. | Buildings. | Machinery. | Supplies. | No. | Horse power. | No. | Horse power. |
| **Total** | $4, 239, 955 | $41, 778 | $16, 633 | $148, 067 | $155, 343 | $83, 000 | $3, 778, 467 | $16, 667 | $556, 307 | $53, 788 | $465, 719 | $36, 800 | 2 | 360 | 2 | 300 |
| **Harris** | 3, 181, 630 | 31, 341 | 13, 300 | 111, 050 | 117, 339 | 62, 250 | 2, 833, 850 | 12, 500 | 417, 230 | 40, 341 | 349, 289 | 27, 600 | 2 | 360 | 2 | 300 |
| **Sheep Creek** | 1, 058, 325 | 10, 437 | 3, 333 | 37, 017 | 38, 004 | 20, 750 | 944, 617 | 4, 167 | 139, 077 | 13, 447 | 116, 430 | 9, 200 | .... | ........ | .... | ...... |
| **Silver Bow Basin placer** | | | | | | | | | | | | | | | | |
| **Yukon Union and Yukon placers.** | | | | | | | | | | | | | | | | |
| **Undistributed gold** | | | | | | | | | | | | | | | | |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES.

### ARIZONA.

| COUNTIES. | Total amount of ore produced. (Short tons.) | Total amount of ore sold. (Short tons.) | Total amount of ore treated. (Short tons.) | ASSAY VALUE OF ORE SOLD. | | TOTAL BULLION VALUE. | | | ESTIMATED COINING VALUE OF BULLION PRODUCED FROM ORE SOLD. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gold. | Silver. | Grand total bullion. | Gold. | Silver. | Gold. | Silver. |
| Total | 104, 554 | 17, 243 | 34, 221 | $406, 474 | $1, 555, 225 | $3, 254, 151 | $910, 174 | $2, 343, 977 | $386, 151 | $1, 477, 465 |
| Cochise | 22, 895 | 3, 843 | | 47, 758 | 407, 470 | 811, 675 | 62, 370 | 749, 305 | 45, 370 | 387, 097 |
| Gila | 176 | 94 | 79 | 252 | 24, 810 | 61, 865 | 240 | 61, 625 | 240 | 23, 570 |
| Graham | 120 | 120 | | 720 | 4, 800 | 5, 244 | 684 | 4, 560 | 684 | 4, 560 |
| Maricopa | 5, 562 | | 5, 137 | | | 41, 166 | 39, 849 | 1, 317 | | |
| Mohave | 3, 079 | 1, 288 | 1, 316 | 13, 625 | 209, 788 | 260, 290 | 42, 799 | 217, 491 | 12, 944 | 199, 299 |
| Pima | 35, 893 | 3, 341 | 12, 961 | | 390, 470 | 738, 316 | 57, 306 | 681, 010 | | 370, 947 |
| Pinal | 8, 721 | 336 | 7, 401 | 1, 800 | 76, 559 | 194, 135 | 1, 710 | 192, 425 | 1, 710 | 72, 731 |
| Yavapai | 24, 988 | 7, 351 | 5, 077 | 342, 319 | 355, 636 | 809, 758 | 454, 921 | 354, 837 | 325, 203 | 337, 854 |
| Yuma | 3, 120 | 870 | 2, 250 | | 85, 692 | 181, 702 | 100, 295 | 81, 407 | | 81, 407 |
| Undistributed gold | | | | | | 150, 000 | 150, 000 | | | |

| COUNTIES. | COINING VALUE OF BULLION PRODUCED FROM ORE TREATED. | | PLACER BULLION. | | Total producing mines reported. | NUMBER OF MINES PRODUCING— | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gold. | Silver. | Gold. | Silver. | | Less than $1,000. | $1,000 to $10,000. | $10,000 to $50,000. | $50,000 to $100,000. | $100,000 to $250,000. | $250,000 to $500,000. | Over $500,000. |
| Total | $258, 370 | $914, 040 | $60, 495 | | 154 | 26 | 82 | 34 | 7 | 4 | 1 | |
| Cochise | 17, 000 | 362, 208 | | | 13 | | 5 | 3 | 3 | 1 | 1 | |
| Gila | | 38, 055 | | | 5 | 1 | 2 | 2 | | | | |
| Graham | | | | | 1 | | 1 | | | | | |
| Maricopa | 34, 649 | 1, 317 | 5, 200 | | 7 | 2 | 4 | 1 | | | | |
| Mohave | 29, 855 | 18, 192 | | | 25 | 8 | 12 | 4 | 1 | | | |
| Pima | 2, 148 | 357, 591 | | | 8 | 1 | 1 | 4 | 1 | 1 | | |
| Pinal | | 119, 694 | | | 6 | | 4 | | 1 | 1 | | |
| Yavapai | 129, 718 | 16, 983 | | | 84 | 14 | 53 | 16 | | 1 | | |
| Yuma | 45, 000 | | 55, 295 | | 5 | | | 4 | 1 | | | |
| Undistributed gold | | | | | | | | | | | | |

| COUNTIES. | EMPLOYÉS ABOVE GROUND. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | |
| | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. |
| Total | 64 | 118 | 703 | 2 | $4. 59 | $3. 89 | $2. 46 | $1. 50 | 219 | 187 | 205 | 145 |
| Cochise | 6 | 28 | 49 | | 5. 50 | 4. 13 | 2. 62 | | 340 | 308 | 248 | |
| Gila | | | 10 | | | | 3. 00 | | | | 60 | |
| Graham | | | | | | | | | | | | |
| Maricopa | 7 | 7 | 42 | | 4. 67 | 3. 67 | 2. 63 | | 293 | 216 | 284 | |
| Mohave | 6 | 4 | 15 | | 5. 33 | 4. 00 | 3. 10 | | 196 | 257 | 190 | |
| Pima | 26 | 26 | 185 | | 4. 20 | 4. 00 | 2. 12 | | 210 | 82 | 190 | |
| Pinal | 3 | 16 | 33 | | 4. 17 | 3. 75 | 2. 41 | | 164 | 170 | 206 | |
| Yavapai | 16 | 28 | 53 | 2 | 4. 63 | 3. 95 | 2. 90 | 1. 50 | 176 | 166 | 197 | 145 |
| Yuma | | 9 | 20 | | | 3. 00 | 3. 00 | | | 150 | 180 | |
| Undistributed gold | | | 296 | | | | 2. 46 | | | | 205 | |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### ARIZONA—Continued.

| COUNTIES. | EMPLOYÉS BELOW GROUND. | | | | | | | | | | | | Total number of mines. | Number of producing mines. | Mines working but non-productive. | Number of mines idle. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | | | | | |
| | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | | | | |
| Total | 34 | 1,467 | 132 | 1 | $4.44 | $3.17 | $2.24 | $1.50 | 193 | 215 | 199 | 89 | 192 | 154 | 14 | 24 |
| Cochise | 8 | 233 | 3 | | 5.13 | 3.03 | 3.00 | | 251 | 297 | 338 | | 21 | 13 | 4 | 4 |
| Gila | | 38 | | | | 3.09 | | | | 231 | | | 9 | 5 | 2 | 2 |
| Graham | | 10 | | | | 3.00 | | | | 100 | | | 1 | 1 | | |
| Maricopa | | 205 | 22 | | | 3.15 | 2.66 | | | 142 | 300 | | 11 | 7 | 2 | 2 |
| Mohave | 4 | 133 | 15 | | 4.75 | 3.39 | 3.20 | | 260 | 211 | 207 | | 25 | 25 | | |
| Pima | 10 | 296 | 55 | | 3.75 | 2.89 | 1.40 | | 105 | 191 | 133 | | 12 | 8 | 2 | 2 |
| Pinal | 3 | 75 | 21 | | 4.66 | 3.11 | 2.52 | | 251 | 256 | 218 | | 12 | 6 | 1 | 5 |
| Yavapai | 8 | 395 | 16 | 1 | 4.44 | 3.47 | 2.84 | 1.50 | 197 | 222 | 230 | 89 | 96 | 84 | 3 | 9 |
| Yuma | 1 | 82 | | | 4.00 | 3.00 | | | 150 | 194 | | | 5 | 5 | | |
| Undistributed gold | | | | | | | | | | | | | | | | |

| COUNTIES. | EXPENDITURES. | | | | | | | | | | VALUE OF MINING PROPERTY. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grand total of expenditures. | Grand total of wages. | Total wages paid in 1889. | Paid to contractors. | Office force. | | | | Value of supplies | Other expenditures. | Total value of plant. | Value of buildings. | Value of railroads on surface. | Machinery. | Underground improvements. |
| | | | | | Males. | | Females. | | | | | | | | |
| | | | | | Number. | Wages paid. | Number. | Wages paid. | | | | | | | |
| Total | $2,058,039 | $1,599,259 | $1,499,641 | $48,902 | 30 | $50,716 | | | $348,662 | $110,118 | $19,734,884 | $207,264 | $17,800 | $469,497 | $1,906,560 |
| Cochise | 453,919 | 327,789 | 311,584 | 5,000 | 8 | 11,205 | | | 71,873 | 54,257 | 1,546,850 | 64,600 | 2,950 | 58,400 | 146,000 |
| Gila | 31,637 | 27,837 | 27,837 | | | | | | 2,750 | 1,050 | 229,700 | 4,000 | | 19,200 | 33,000 |
| Graham | 3,000 | 3,000 | 3,000 | | | | | | | | | | | | |
| Maricopa | 227,297 | 194,227 | 140,547 | 37,840 | 2 | 15,840 | | | 24,270 | 8,800 | 2,976,600 | 24,200 | 4,400 | 27,500 | 118,800 |
| Mohave | 143,436 | 128,183 | 128,183 | | | | | | 7,355 | 7,898 | 839,763 | 14,275 | 2,200 | 42,400 | 106,800 |
| Pima | 341,692 | 267,132 | 256,199 | 1,937 | 8 | 8,996 | | | 68,099 | 6,461 | 6,388,304 | 46,514 | | 155,857 | 972,400 |
| Pinal | 184,055 | 108,656 | 100,781 | | 6 | 7,875 | | | 68,690 | 6,709 | 3,082,550 | 14,700 | 100 | 18,850 | 102,000 |
| Yavapai | 451,013 | 329,345 | 318,420 | 4,125 | 6 | 6,800 | | | 98,025 | 23,643 | 4,371,117 | 34,725 | 8,150 | 136,090 | 409,560 |
| Yuma | 71,990 | 63,090 | 63,090 | | | | | | 7,600 | 1,300 | 300,000 | 4,250 | | 11,200 | 18,000 |
| Undistributed gold | 150,000 | 150,000 | 150,000 | | | | | | | | | | | | |

| COUNTIES. | VALUE OF MINING PROPERTY—continued. | | | VALUE OF MILL OR REDUCTION WORKS. | | | | MOTIVE POWER. | | | | | | | Number of animals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mine supplies. | Mine proper. | Cash. | Total. | Buildings. | Machinery. | Supplies. | Boilers. | | Engines. | | Other power. | Motors. | | |
| | | | | | | | | Number. | Horse power. | Number. | Horse power. | | Number. | Horse power. | |
| Total | $105,370 | $17,018,293 | $10,100 | $828,495 | $198,060 | $585,835 | $44,600 | 88 | 2,563 | 60 | 1,030 | | 2 | 40 | 354 |
| Cochise | 2,390 | 1,267,510 | 5,000 | 56,900 | 8,500 | 47,500 | 900 | 18 | 516 | 14 | 296 | Whims, 3<br>Windlasses, 3 | | | 4 |
| Gila | | 172,500 | 1,000 | 23,000 | 1,000 | 20,000 | 2,000 | | | | | Whim, 1<br>Windlasses, 3 | | | 1 |
| Graham | | | | | | | | | | | | | | | |
| Maricopa | | 2,801,700 | | 180,400 | 26,400 | 147,400 | 6,600 | 15 | 299 | 13 | 396 | Windlass, 1 | | | 11 |
| Mohave | 38,400 | 635,688 | | 75,400 | 24,200 | 39,000 | 12,200 | 7 | 301 | 6 | 208 | Windlasses, 3 | | | 34 |
| Pima | 4,173 | 5,209,360 | | 138,060 | 45,760 | 88,400 | 3,900 | 23 | 546 | 13 | 86 | Windlasses, 8<br>Whims, 8<br>Whips. 5 | | | 83 |
| Pinal | 5,000 | 2,941,900 | | 88,000 | 16,000 | 68,000 | 4,000 | 2 | 150 | 2 | | Windlass, 1<br>Whim, 1<br>Hoist, 1 | | | 72 |
| Yavapai | 55,407 | 3,723,085 | 4,100 | 260,735 | 75,200 | 170,535 | 15,000 | 20 | 661 | 11 | 44 | Whims, 9<br>Wheel, 1 | 2 | 40 | 149 |
| Yuma | | 266,550 | | 6,000 | 1,000 | 5,000 | | 3 | 90 | 1 | | Windlass, 1 | | | |
| Undistributed gold | | | | | | | | | | | | | | | |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### CALIFORNIA.

| COUNTIES. | Total amount of ore produced. (Short tons.) | Total amount of ore sold. (Short tons.) | Total amount of ore treated. (Short tons.) | ASSAY VALUE OF ORE SOLD. | | TOTAL BULLION VALUE. | | | ESTIMATED COINING VALUE OF BULLION PRODUCED FROM ORE SOLD. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gold. | Silver. | Grand total bullion. | Gold. | Silver. | Gold. | Silver. |
| Total | 1, 032, 124 | 4, 721 | 996, 114 | $203, 969 | $149, 121 | $13, 960, 529 | $12, 586, 722 | $1, 373, 807 | $193, 866 | $141, 664 |
| Alpine | | | | | | | | | | |
| Amador | 171, 650 | | 171, 550 | | | 911, 252 | 908, 246 | 3, 006 | | |
| Butte | 7, 851 | 6 | 7, 506 | 42 | 137 | 301, 592 | 300, 680 | 912 | 39 | 130 |
| Calaveras | 118, 441 | 116 | 113, 079 | 7, 155 | 3, 755 | 736, 881 | 733, 058 | 3, 823 | 6, 797 | 3, 567 |
| Colusa | 200 | | 200 | | | 4, 187 | 4, 061 | 126 | | |
| Del Norte | | | | | | 17, 400 | 17, 400 | | | |
| Eldorado | 6, 100 | 23 | 5, 712 | 2, 639 | 8 | 183, 575 | 183, 210 | 365 | 2, 507 | 8 |
| Fresno | 45, 158 | 650 | 14, 359 | 20, 920 | 23, 430 | 207, 523 | 180, 697 | 26, 826 | 19, 874 | 22, 259 |
| Humboldt | | | | | | 78, 847 | 78, 709 | 138 | | |
| Inyo | 3, 288 | 1, 434 | 1, 311 | 22, 316 | 105, 938 | 148, 025 | 43, 645 | 104, 380 | 21, 200 | 100, 641 |
| Kern | 2, 561 | 2 | 2, 419 | 645 | 18 | 60, 750 | 60, 472 | 278 | 613 | 17 |
| Lassen | 1, 731 | | 1, 721 | | | 22, 700 | 22, 026 | 674 | | |
| Los Angeles | 5, 200 | | 5, 200 | | | 79, 109 | 78, 609 | 500 | | |
| Mariposa | 3, 651 | | 981 | | | 20, 052 | 20, 052 | | | |
| Merced | | | | | | 100 | 100 | | | |
| Mono | 12, 536 | 353 | 11, 680 | 8, 702 | 4, 755 | 206, 398 | 180, 408 | 25, 990 | 8, 267 | 4, 517 |
| Monterey | 250 | | 250 | | | 3, 600 | 3, 600 | | | |
| Napa | 2, 100 | | 2, 100 | | | 50, 206 | 307 | 49, 899 | | |
| Nevada | 171, 938 | 1, 015 | 192, 127 | 51, 653 | | 2, 006, 757 | 1, 967, 649 | 39, 108 | 49, 070 | |
| Orange | 10 | 10 | | | 1, 000 | 950 | | 950 | | 950 |
| Placer | 152, 176 | 30 | 151, 637 | 1, 113 | 557 | 1, 215, 594 | 1, 211, 209 | 4, 385 | 1, 057 | 530 |
| Plumas | 73, 102 | | 69, 958 | | | 499, 430 | 499, 077 | 353 | | |
| Sacramento | | | | | | 166, 000 | 166, 000 | | | |
| San Bernardino | 73, 217 | 244 | 72, 778 | 1, 285 | 6, 648 | 1, 108, 222 | 2, 821 | 1, 105, 401 | 1, 221 | 6, 316 |
| San Diego | 8, 137 | | 8, 069 | | | 251, 073 | 251, 071 | 2 | | |
| San Luis Obispo | | | | | | | | | | |
| Santa Barbara | | | | | | 7, 045 | 7, 045 | | | |
| Shasta | 28, 179 | 614 | 24, 845 | 71 117 | 2, 880 | 332, 996 | 328, 964 | 4, 032 | 67, 658 | 2, 734 |
| Sierra | 97, 186 | | 93, 256 | | | 1, 329, 192 | 1, 327, 290 | 1, 902 | | |
| Siskiyou | 9, 674 | | 9, 422 | | | 808, 198 | 807, 910 | 288 | | |
| Stanislaus | | | | | | 15, 955 | 15, 955 | | | |
| Trinity | 15, 485 | | 15, 327 | | | 683, 542 | 683, 427 | 115 | | |
| Tulare | 876 | | 876 | | | 17, 110 | 17, 109 | 1 | | |
| Tuolumne | 19, 657 | 224 | 18, 181 | 16, 382 | | 228, 550 | 228, 337 | 213 | 15, 563 | |
| Ventura | 820 | | 620 | | | 6, 831 | 6, 831 | | | |
| Yuba | 950 | | 950 | | | 98, 513 | 98, 373 | 140 | | |
| Undistributed placer gold. | | | | | | 2, 152, 374 | 2, 152, 374 | | | |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### CALIFORNIA—Continued.

| COUNTIES. | COINING VALUE OF BULLION PRODUCED FROM ORE TREATED. | | PLACER BULLION. | | Total producing mines reported. | NUMBER OF MINES PRODUCING— | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gold. | Silver. | Gold. | Silver. | | Less than $1,000. | $1,000 to $10,000. | $10,000 to $50,000. | $50,000 to $100,000. | $100,000 to $250,000. | $250,000 to $500,000. | Over $500,000. |
| Total | $6, 635, 612 | $1, 230, 682 | $3, 604, 962 | $1, 431 | 1, 359 | 627 | 583 | 102 | 18 | 21 | 6 | 2 |
| Alpine | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Amador | 905, 804 | 2, 993 | 2, 442 | 13 | 18 | 3 | 5 | 2 | 4 | 4 | ........ | ........ |
| Butte | 52, 261 | 782 | 248, 380 | ........ | 147 | 87 | 56 | 4 | ........ | ........ | ........ | ........ |
| Calaveras | 635, 089 | 251 | 91, 172 | 5 | 29 | 8 | 11 | 6 | 2 | 1 | 1 | ........ |
| Colusa | 4, 061 | 126 | ........ | ........ | 1 | ........ | 1 | ........ | ........ | ........ | ........ | ........ |
| Del Norte | ........ | ........ | 17, 400 | ........ | 3 | 1 | 2 | ........ | ........ | ........ | ........ | ........ |
| Eldorado | 77, 289 | 362 | 103, 414 | ........ | 66 | 40 | 24 | 2 | ........ | ........ | ........ | ........ |
| Fresno | 160, 823 | 4, 567 | ........ | ........ | 21 | 6 | 9 | 4 | 1 | 1 | ........ | ........ |
| Humboldt | ........ | ........ | 78, 709 | 138 | 30 | 15 | 13 | 2 | ........ | ........ | ........ | ........ |
| Inyo | 22, 445 | 3, 739 | ........ | ........ | 35 | 17 | 12 | 1 | 1 | 2 | 1 | 1 |
| Kern | 58, 007 | 261 | 1, 852 | ........ | 32 | 19 | 13 | ........ | ........ | ........ | ........ | ........ |
| Lassen | 22, 026 | 674 | ........ | ........ | 7 | 2 | 5 | ........ | ........ | ........ | ........ | ........ |
| Los Angeles | 78, 609 | 500 | ........ | ........ | 2 | ........ | ........ | 2 | ........ | ........ | ........ | ........ |
| Mariposa | 16, 269 | ........ | 3, 785 | ........ | 21 | 14 | 7 | ........ | ........ | ........ | ........ | ........ |
| Merced | ........ | ........ | 100 | ........ | 1 | 1 | ........ | ........ | ........ | ........ | ........ | ........ |
| Mono | 172, 141 | 21, 473 | ........ | ........ | 9 | 2 | 6 | ........ | ........ | 1 | ........ | ........ |
| Monterey | 3, 600 | ........ | ........ | ........ | 1 | ........ | 1 | ........ | ........ | ........ | ........ | ........ |
| Napa | 307 | 49, 899 | ........ | ........ | 1 | ........ | ........ | ........ | 1 | ........ | ........ | ........ |
| Nevada | 1, 715, 248 | 38, 931 | 203, 331 | 177 | 58 | 10 | 32 | 7 | 2 | 5 | 2 | ........ |
| Orange | ........ | ........ | ........ | ........ | 1 | ........ | 1 | ........ | ........ | ........ | ........ | ........ |
| Placer | 748, 121 | 3, 840 | 462, 031 | 15 | 74 | 23 | 32 | 13 | 3 | 2 | 1 | ........ |
| Plumas | 407, 793 | 123 | 91, 284 | 230 | 39 | 15 | 20 | 3 | ........ | ........ | 1 | ........ |
| Sacramento | ........ | ........ | 166, 000 | ........ | 50 | 20 | 28 | 2 | ........ | ........ | ........ | ........ |
| San Bernardino | ........ | 1, 099, 085 | 1, 600 | ........ | 14 | 3 | 7 | 2 | ........ | 1 | ........ | 1 |
| San Diego | 251, 071 | 2 | ........ | ........ | 4 | 2 | 1 | ........ | ........ | 1 | ........ | ........ |
| San Luis Obispo | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Santa Barbara | ........ | ........ | 7, 045 | ........ | 2 | ........ | 2 | ........ | ........ | ........ | ........ | ........ |
| Shasta | 259, 316 | 1, 268 | 2, 080 | ........ | 30 | 16 | 8 | 5 | 1 | ........ | ........ | ........ |
| Sierra | 319, 452 | 1, 213 | 1, 007, 838 | 689 | 136 | 70 | 50 | 12 | 2 | 2 | ........ | ........ |
| Siskiyou | 160, 441 | 274 | 647, 469 | 14 | 264 | 121 | 133 | 10 | ........ | ........ | ........ | ........ |
| Stanislaus | ........ | ........ | 15, 955 | ........ | 2 | 1 | ........ | 1 | ........ | ........ | ........ | ........ |
| Trinity | 367, 835 | 115 | 315, 592 | ........ | 193 | 112 | 68 | 11 | 1 | 1 | ........ | ........ |
| Tulare | 17, 109 | 1 | ........ | ........ | 3 | 2 | ........ | 1 | ........ | ........ | ........ | ........ |
| Tuolumne | 167, 789 | 203 | 44, 985 | 10 | 38 | 8 | 20 | 10 | ........ | ........ | ........ | ........ |
| Ventura | 6, 831 | ........ | ........ | ........ | 2 | ........ | 2 | ........ | ........ | ........ | ........ | ........ |
| Yuba | 5, 875 | ........ | 92, 498 | 140 | 25 | 9 | 14 | 2 | ........ | ........ | ........ | ........ |
| Undistributed placer gold. | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### CALIFORNIA—Continued

| COUNTIES. | EMPLOYÉS ABOVE GROUND. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | |
| | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. |
| Total | 565 | 660 | 6,231 | 21 | $3.30 | $3.26 | $2.05 | $1.29 | 182 | 196 | 147 | 129 |
| Alpine | | | 2 | | | | 2.00 | | | | 12 | |
| Amador | 17 | 46 | 116 | 3 | 3.85 | 2.98 | 2.58 | 1.08 | 278 | 294 | 218 | 264 |
| Butte | 11 | 13 | 71 | | 3.12 | 3.60 | 2.91 | | 231 | 154 | 114 | |
| Calaveras | 15 | 48 | 54 | 1 | 3.44 | 3.28 | 2.37 | 1.50 | 248 | 188 | 204 | 54 |
| Colusa | | | 1 | | | | 2.50 | | | | 300 | |
| Del Norte | | | 1 | | | | 2.50 | | | | 150 | |
| Eldorado | 36 | 48 | 165 | 3 | 2.99 | 3.01 | 2.23 | 1.50 | 190 | 165 | 89 | 150 |
| Fresno | 4 | 28 | 57 | | 3.75 | 3.65 | 2.78 | | 153 | 202 | 189 | |
| Humboldt | 14 | | 78 | | 2.44 | | 1.96 | | 73 | | 176 | |
| Inyo | 12 | 10 | 49 | | 5.16 | 4.93 | 2.83 | | 179 | 131 | 91 | |
| Kern | 10 | 5 | 23 | 2 | 3.09 | 3.00 | 2.22 | 1.75 | 158 | 138 | 115 | 62 |
| Lassen | 1 | | 2 | | 3.00 | | 1.92 | | 300 | | 90 | |
| Los Angeles | 5 | 3 | 5 | | 3.56 | 3.00 | 2.40 | | 322 | 245 | 311 | |
| Mariposa | 1 | 3 | 15 | 2 | 3.50 | 3.50 | 2.40 | 1.00 | 270 | 270 | 98 | 155 |
| Merced | | | 1 | | | | 3.00 | | | | 30 | |
| Mono | 5 | 6 | 18 | | 3.60 | 4.68 | 3.24 | | 290 | 326 | 231 | |
| Monterey | | 2 | 5 | | | 4.50 | 3.00 | | | 78 | 78 | |
| Napa | 2 | 1 | 7 | | 4.00 | 5.00 | 2.00 | | 209 | 209 | 209 | |
| Nevada | 32 | 121 | 229 | | 4.05 | 3.19 | 2.51 | | 227 | 230 | 227 | |
| Orange | | | | | | | | | | | | |
| Placer | 25 | 83 | 301 | 2 | 3.82 | 2.67 | 2.19 | 2.13 | 150 | 136 | 138 | 100 |
| Plumas | 20 | 28 | 135 | | 3.20 | 3.03 | 2.60 | | 231 | 266 | 200 | |
| Sacramento | 8 | | 188 | | 2.75 | | 1.83 | | 265 | | 221 | |
| San Bernardino | 13 | 13 | 156 | | 4.10 | 3.62 | 2.99 | | 207 | 183 | 295 | |
| San Diego | 6 | 7 | 37 | | 4.60 | 3.91 | 2.73 | | 273 | 133 | 197 | |
| San Luis Obispo | | | 1 | | | | 1.16 | | | | 60 | |
| Santa Barbara | | | 10 | | | | 2.00 | | | | 100 | |
| Shasta | 11 | 35 | 84 | | 4.13 | 3.33 | 2.17 | | 245 | 276 | 199 | |
| Sierra | 34 | 62 | 1,540 | 2 | 3.82 | 3.75 | 1.93 | 0.75 | 181 | 187 | 87 | 100 |
| Siskiyou | 135 | 18 | 1,234 | 1 | 3.09 | 2.55 | 1.87 | 1.00 | 161 | 141 | 153 | 30 |
| Stanislaus | 4 | | 39 | | 3.00 | | 1.49 | | 310 | | 305 | |
| Trinity | 117 | 34 | 590 | 3 | 2.74 | 3.72 | 1.67 | 0.83 | 138 | 130 | 168 | 110 |
| Tulare | 1 | 2 | 2 | | 4.00 | 2.00 | 2.00 | | 300 | 100 | 300 | |
| Tuolumne | 21 | 32 | 66 | 1 | 3.40 | 3.48 | 2.48 | 2.00 | 202 | 184 | 175 | 30 |
| Ventura | 2 | 1 | 8 | | 3.50 | 3.00 | 2.94 | | 259 | 365 | 339 | |
| Yuba | 3 | 11 | 137 | 1 | 4.83 | 2.79 | 1.88 | 1.00 | 159 | 101 | 140 | 191 |
| Undistributed placer gold. | | | 714 | | | | 2.04 | | | | 146 | |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### CALIFORNIA—Continued.

| COUNTIES. | EMPLOYÉS BELOW GROUND. | | | | | | | | | | | | Total number of mines. | Number of producing mines. | Mines working but non-productive. | Number of mines idle. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | | | | | |
| | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | | | | |
| Total | 303 | 5,522 | 944 | 8 | $3.49 | $2.74 | $2.28 | $1.50 | 217 | 209 | 237 | 103 | 2,109 | 1,359 | 244 | 506 |
| Alpine | ........ | 12 | ........ | ........ | ........ | 3.08 | ........ | ........ | ........ | 45 | ........ | ........ | 13 | ........ | 7 | 6 |
| Amador | 11 | 382 | 61 | 1 | 4.00 | 2.99 | 2.40 | 1.00 | 303 | 304 | 295 | 265 | 40 | 18 | 3 | 19 |
| Butte | 11 | 238 | 19 | ........ | 3.37 | 2.58 | 2.28 | ........ | 230 | 144 | 129 | ........ | 174 | 147 | 7 | 20 |
| Calaveras | 12 | 309 | 24 | ........ | 3.51 | 2.40 | 2.38 | ........ | 285 | 276 | 146 | ........ | 64 | 29 | 2 | 33 |
| Colusa | 1 | 2 | ........ | ........ | 4.00 | 2.50 | ........ | ........ | 300 | 300 | ........ | ........ | 1 | 1 | ........ | ........ |
| Del Norte | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 3 | 3 | ........ | ........ |
| Eldorado | 27 | 495 | 30 | ........ | 3.33 | 2.51 | 2.40 | ........ | 149 | 169 | 242 | ........ | 113 | 66 | 11 | 36 |
| Fresno | 3 | 160 | 26 | 1 | 4.26 | 2.88 | 2.09 | 1.00 | 267 | 183 | 159 | 18 | 41 | 21 | 6 | 14 |
| Humboldt | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 33 | 30 | 1 | 2 |
| Inyo | 9 | 92 | 11 | ........ | 4.20 | 3.33 | 2.42 | ........ | 213 | 158 | 145 | ........ | 43 | 35 | 1 | 7 |
| Kern | 1 | 58 | 12 | ........ | 4.00 | 2.71 | 2.41 | ........ | 300 | 149 | 182 | ........ | 44 | 32 | 3 | 9 |
| Lassen | 3 | 13 | 11 | ........ | 3.50 | 2.45 | 2.40 | ........ | 300 | 144 | 255 | ........ | 16 | 7 | 6 | 3 |
| Los Angeles | 1 | 18 | 10 | ........ | 4.00 | 3.00 | 2.05 | ........ | 311 | 261 | 302 | ........ | 27 | 2 | ........ | 25 |
| Mariposa | 3 | 85 | 11 | ........ | 3.33 | 2.76 | 2.11 | ........ | 255 | 124 | 147 | ........ | 83 | 21 | 22 | 40 |
| Merced | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 2 | 1 | ........ | 1 |
| Mono | 5 | 72 | 10 | ........ | 4.82 | 3.77 | 3.70 | ........ | 308 | 167 | 301 | ........ | 27 | 9 | 6 | 12 |
| Monterey | 1 | 12 | ........ | ........ | 4.00 | 3.00 | ........ | ........ | 300 | 284 | ........ | ........ | 1 | 1 | ........ | ........ |
| Napa | 1 | 15 | 8 | ........ | 3.00 | 2.50 | 1.75 | ........ | 209 | 209 | 209 | ........ | 5 | 1 | ........ | 4 |
| Nevada | 28 | 452 | 253 | ........ | 2.93 | 2.73 | 2.29 | ........ | 255 | 252 | 240 | ........ | 106 | 58 | 7 | 41 |
| Orange | 1 | 5 | 2 | ........ | 3.00 | 2.50 | 2.50 | ........ | 60 | 52 | 30 | ........ | 18 | 1 | 3 | 14 |
| Placer | 63 | 710 | 102 | 4 | 3.36 | 2.71 | 2.05 | 1.88 | 176 | 195 | 267 | 80 | 157 | 74 | 44 | 39 |
| Plumas | 12 | 252 | 49 | ........ | 3.50 | 2.58 | 2.09 | ........ | 244 | 237 | 284 | ........ | 76 | 39 | 9 | 28 |
| Sacramento | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 54 | 50 | ........ | 4 |
| San Bernardino | 2 | 115 | 86 | ........ | 6.00 | 3.05 | 3.00 | ........ | 333 | 271 | 328 | ........ | 40 | 14 | 9 | 17 |
| San Diego | 7 | 86 | 12 | ........ | 4.41 | 2.94 | 2.70 | ........ | 141 | 219 | 193 | ........ | 15 | 4 | 2 | 9 |
| San Luis Obispo | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 1 | ........ | 1 | ........ |
| Santa Barbara | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 4 | 2 | ........ | 2 |
| Shasta | 8 | 158 | 26 | ........ | 3.65 | 2.89 | 2.20 | ........ | 294 | 157 | 238 | ........ | 47 | 30 | 6 | 11 |
| Sierra | 42 | 940 | 28 | ........ | 3.68 | 2.77 | 2.60 | ........ | 232 | 215 | 197 | ........ | 196 | 136 | 37 | 23 |
| Siskiyou | 16 | 251 | 81 | ........ | 2.79 | 2.38 | 1.67 | ........ | 183 | 142 | 201 | ........ | 324 | 264 | 30 | 30 |
| Stanislaus | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 8 | 2 | ........ | 6 |
| Trinity | 16 | 192 | 31 | 1 | 3.20 | 3.19 | 1.90 | 1.50 | 158 | 184 | 126 | 30 | 214 | 193 | 15 | 6 |
| Tulare | ........ | 8 | ........ | ........ | ........ | 2.50 | ........ | ........ | ........ | 188 | ........ | ........ | 4 | 3 | ........ | 1 |
| Tuolumne | 13 | 302 | 27 | ........ | 3.83 | 2.79 | 2.32 | ........ | 236 | 217 | 190 | ........ | 62 | 38 | 3 | 21 |
| Ventura | 1 | 8 | 2 | ........ | 4.00 | 3.44 | 2.50 | ........ | 365 | 319 | 365 | ........ | 13 | 2 | ........ | 11 |
| Yuba | 5 | 80 | 12 | 1 | 2.85 | 2.20 | 2.00 | 1.00 | 236 | 211 | 191 | 191 | 40 | 25 | 3 | 12 |
| Undistributed placer gold. | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### CALIFORNIA—Continued.

| COUNTIES. | EXPENDITURES. | | | | | | | | | | VALUE OF MINING PROPERTY. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grand total of expenditures. | Grand total of wages. | Total wages paid in 1889. | Paid to contractors. | Office force. | | | | Value of supplies. | Other expenditures. | Total value of plant. | Value of buildings. | Value of railroads on surface. | Machinery. | Underground improvements. |
| | | | | | Males. | | Females. | | | | | | | | |
| | | | | | Number. | Wages paid. | Number. | Wages paid. | | | | | | | |
| Total | $12,506,555 | $9,689,265 | $9,191,500 | $296,373 | 160 | $199,955 | 4 | $1,437 | $2,151,229 | $666,061 | $67,641,986 | $1,662,014 | $238,467 | $4,330,986 | $12,305,794 |
| Alpine | 2,508 | 1,882 | 1,882 | | | | | | 626 | | 641,000 | 14,100 | | 30,200 | 306,000 |
| Amador | 783,381 | 494,172 | 470,242 | 7,500 | 15 | 16,430 | | | 242,023 | 47,186 | 7,126,166 | 252,060 | 12,265 | 407,757 | 646,392 |
| Butte | 455,227 | 410,547 | 394,752 | 135 | 14 | 15,660 | | | 41,526 | 3,154 | 6,023,498 | 84,105 | 21,330 | 190,458 | 3,227,539 |
| Calaveras | 505,065 | 335,906 | 326,536 | 2,915 | 6 | 6,455 | | | 156,724 | 12,435 | 1,478,310 | 112,325 | 3,705 | 89,843 | 98,400 |
| Colusa | 3,600 | 3,450 | 3,450 | | | | | | 100 | 50 | 100,000 | 6,000 | | 20,000 | 6,000 |
| Del Norte | 595 | 375 | 375 | | | | | | 200 | 20 | 1,000 | 100 | | 250 | |
| Eldorado | 434,949 | 331,500 | 283,065 | 29,055 | 15 | 19,380 | | | 75,447 | 28,002 | 3,851,511 | 125,190 | 2,625 | 258,090 | 470,760 |
| Fresno | 210,716 | 171,972 | 149,518 | 13,792 | 7 | 8,662 | | | 34,353 | 4,391 | 1,946,258 | 13,550 | 3,050 | 42,180 | 180,903 |
| Humboldt | 67,779 | 39,820 | 39,820 | | | | | | 17,084 | 10,875 | 427,559 | 19,813 | 1,530 | 20,732 | 6,120 |
| Inyo | 141,610 | 107,949 | 97,149 | 5,750 | 5 | 5,050 | | | 17,479 | 16,182 | 959,665 | 14,570 | 2,000 | 19,880 | 112,300 |
| Kern | 52,442 | 41,632 | 40,111 | 321 | 1 | 1,200 | | | 8,322 | 2,488 | 441,090 | 8,360 | 2,340 | 23,152 | 89,040 |
| Lassen | 20,548 | 17,084 | 17,084 | | | | | | 1,860 | 1,604 | 47,110 | 2,500 | 155 | 625 | 10,480 |
| Los Angeles | 45,818 | 37,220 | 34,820 | | 1 | 2,400 | | | 7,998 | 600 | 120,000 | 1,400 | 1,200 | 1,300 | 18,000 |
| Mariposa | 60,339 | 41,843 | 39,438 | 5 | 1 | 2,400 | | | 10,022 | 8,474 | 1,901,120 | 11,800 | 3,250 | 30,835 | 108,345 |
| Merced | 90 | 90 | 90 | | | | | | | | 1,000 | | | | |
| Mono | 217,011 | 131,821 | 124,619 | 7,202 | | | | | 62,992 | 22,198 | 958,921 | 38,050 | 2,700 | 67,860 | 239,336 |
| Monterey | 10,570 | 6,770 | 6,770 | | | | | | 3,000 | 800 | 12,300 | 1,000 | | 5,000 | 2,000 |
| Napa | 38,000 | 17,000 | 17,000 | | | | | | 20,000 | 1,000 | 84,000 | | | | 1,000 |
| Nevada | 1,640,894 | 1,194,617 | 1,080,627 | 80,183 | 14 | 33,772 | 1 | 35 | 321,763 | 124,514 | 8,086,144 | 150,708 | 15,075 | 518,932 | 1,758,897 |
| Orange | 1,400 | 980 | 980 | | | | | | 420 | | 20,000 | 200 | | 200 | 500 |
| Placer | 922,817 | 669,100 | 621,598 | 36,497 | 9 | 11,005 | | | 196,902 | 56,815 | 4,859,287 | 112,473 | 5,511 | 169,285 | 1,446,324 |
| Plumas | 411,488 | 291,163 | 276,853 | 3,210 | 9 | 11,100 | | | 105,785 | 14,540 | 1,749,691 | 88,950 | 5,675 | 50,895 | 282,664 |
| Sacramento | 119,800 | 83,188 | 83,188 | | | | | | 15,850 | 20,762 | 758,613 | 18,063 | | 6,812 | 1,625 |
| San Bernardino | 510,316 | 334,083 | 319,903 | 9,100 | 7 | 5,080 | | | 120,110 | 56,123 | 3,116,624 | 10,270 | 56,650 | 49,350 | 385,325 |
| San Diego | 185,962 | 144,418 | 115,618 | 24,000 | 2 | 4,800 | | | 29,004 | 12,540 | 2,754,210 | 15,090 | 840 | 64,020 | 91,728 |
| San Luis Obispo | 70 | 70 | 70 | | | | | | | | | | | | |
| Santa Barbara | 2,317 | 2,000 | 2,000 | | | | | | 317 | | 12,000 | | | 50 | |
| Shasta | 325,599 | 199,611 | 184,888 | 2,010 | 9 | 12,713 | | | 105,543 | 20,445 | 1,664,918 | 21,488 | 10,500 | 24,240 | 187,913 |
| Sierra | 1,510,148 | 1,116,106 | 1,063,702 | 26,886 | 26 | 25,518 | | | 275,964 | 118,078 | 9,410,260 | 251,850 | 69,350 | 1,567,918 | 2,004,270 |
| Siskiyou | 553,761 | 527,822 | 516,668 | 5,044 | 7 | 6,110 | | | 111,245 | 14,694 | 4,008,238 | 134,218 | 7,215 | 290,634 | 128,031 |
| Stanislaus | 26,200 | 19,912 | 18,112 | | 1 | 1,800 | | | 3,040 | 3,248 | 20,000 | 500 | | 5,000 | |
| Trinity | 449,419 | 332,257 | 307,784 | 20,348 | 5 | 3,325 | 2 | 800 | 85,319 | 31,843 | 3,047,733 | 100,345 | 4,345 | 223,640 | 145,454 |
| Tulare | 7,892 | 7,192 | 7,192 | | | | | | 100 | 600 | 95,000 | 850 | 50 | 3,100 | 28,200 |
| Tuolumne | 398,756 | 318,468 | 289,351 | 21,420 | 6 | 7,095 | 1 | 602 | 64,401 | 15,887 | 1,331,687 | 44,086 | 6,720 | 129,248 | 258,061 |
| Ventura | 25,810 | 13,290 | 13,290 | | | | | | 1,200 | 11,320 | 115,000 | 400 | | 2,500 | 32,000 |
| Yuba | 111,284 | 91,581 | 90,581 | 1,000 | | | | | 14,510 | 5,193 | 472,073 | 7,600 | 386 | 17,000 | 32,187 |
| Undistributed placer gold. | 2,152,374 | 2,152.374 | 2,152,374 | | | | | | | | | | | | |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### CALIFORNIA—Continued.

| COUNTIES. | VALUE OF MINING PROPERTY—continued. | | | VALUE OF MILL OR REDUCTION WORKS. | | | | MOTIVE POWER. | | | | | | | Number of animals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mine supplies. | Mine proper. | Cash. | Total. | Buildings. | Machinery. | Supplies. | Boilers. | | Engines. | | Other power. | Motors. | | |
| | | | | | | | | Number. | Horse power. | Number. | Horse power. | | Number. | Horse power. | |
| Total | $585,431 | $48,248,811 | $270,483 | $3,792,082 | $976,241 | $2,683,856 | $132,885 | 298 | 9,813 | 266 | 8,633 | ........ | 370 | 12,063 | 1,007 |
| Alpine | 200 | 290,500 | ........ | 125,000 | 12,500 | 112,500 | ........ | 17 | 665 | 9 | 275 | Water, 19<br>Air compressor, 1 | 37 | 614 | 32 |
| Amador | 79,967 | 5,683,809 | 43,916 | 246,675 | 62,700 | 164,575 | 19,400 | 12 | 567 | 8 | 612 | ........ | ........ | ........ | ........ |
| Butte | 9,153 | 2,483,528 | 7,385 | 112,346 | 46,777 | 63,612 | 1,957 | 27 | 670 | 32 | 761 | Whim, 1<br>Water, 24 | 24 | 80 | 8 |
| Calaveras | 7,145 | 1,153,187 | 13,705 | 107,818 | 26,870 | 77,163 | 3,785 | 18 | 545 | 15 | 419 | Water, 14 | 7 | 173 | 18 |
| Colusa | 1,000 | 67,000 | ........ | 27,000 | 6,000 | 20,000 | 1,000 | 2 | 80 | 3 | 80 | ........ | ........ | ........ | 2 |
| Del Norte | ........ | 650 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Eldorado | 32,121 | 2,919,315 | 43,410 | 260,400 | 61,350 | 198,150 | 900 | 27 | 945 | 33 | 687 | Water, 33<br>Windlasses, 9 | 39 | 1,065 | 36 |
| Fresno | 7,975 | 1,697,200 | 1,400 | 86,580 | 15,260 | 56,220 | 15,100 | 9 | 309 | 5 | 152 | Water, 2<br>Windlass, 1 | 3 | 60 | 35 |
| Humboldt | 7,115 | 372,249 | ........ | 1,530 | 1,530 | ........ | ........ | ........ | ........ | ........ | ........ | Hydraulic, 26 | ........ | ........ | 34 |
| Inyo | 5,665 | 805,250 | ........ | 122,630 | 28,145 | 91,650 | 2,835 | 14 | 325 | 10 | 420 | Windlasses, 13<br>Whim, 1<br>Water, 5 | 1 | 8 | 132 |
| Kern | 3,001 | 315,197 | ........ | 23,045 | 2,680 | 19,200 | 1,165 | 11 | 181 | 7 | 219 | Water, 8 | 18 | 367 | 39 |
| Lassen | 550 | 32,800 | ........ | 7,000 | 3,215 | 3,425 | 360 | 2 | 21 | 1 | 65 | Whims, 5<br>Water, 2 | 1 | 10 | 8 |
| Los Angeles | 1,100 | 90,000 | 7,000 | 15,500 | 4,300 | 10,700 | 500 | 1 | 20 | 1 | 21 | Whim, 1 | ........ | ........ | 10 |
| Mariposa | 4,070 | 1,742,820 | ........ | 67,370 | 29,870 | 34,300 | 3,200 | 8 | 370 | 4 | 147 | Water, 7<br>Whim, 1 | 13 | 285 | 9 |
| Merced | ........ | 1,000 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Mono | 7,175 | 599,550 | 4,250 | 112,450 | 27,750 | 78,900 | 5,800 | 8 | 345 | 6 | 410 | Water, 4<br>Air compressor, 1 | 2 | 78 | 21 |
| Monterey | 300 | 4,000 | ........ | ........ | ........ | ........ | ........ | 1 | 45 | 2 | 21 | ........ | ........ | ........ | ........ |
| Napa | ........ | 83,000 | ........ | 16,000 | 5,000 | 10,000 | 1,000 | 2 | 40 | 2 | 40 | ........ | ........ | ........ | ........ |
| Nevada | 49,704 | 5,548,087 | 44,741 | 379,114 | 83,304 | 284,544 | 11,266 | 18 | 995 | 23 | 911 | Water, 22<br>Steam, 1<br>Pelton wheel, 1 | 50 | 1,971 | 19 |
| Orange | 100 | 19,000 | ........ | 150 | ........ | 150 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Placer | 25,814 | 3,054,988 | 44,892 | 247,223 | 60,487 | 171,232 | 15,504 | 27 | 1,014 | 25 | 1,066 | Water, 26 | 35 | 559 | 50 |
| Plumas | 16,807 | 1,304,700 | ........ | 218,420 | 47,350 | 157,170 | 13,900 | 5 | 290 | 6 | 358 | Water, 21 | 14 | 697 | 16 |
| Sacramento | 16,925 | 715,188 | ........ | 11,363 | 875 | 8,750 | 1,738 | ........ | ........ | ........ | ........ | Water, 5 | ........ | ........ | 40 |
| San Bernardino | 34,975 | 2,579,200 | 854 | 372,050 | 111,950 | 250,400 | 9,700 | 14 | 422 | 6 | 227 | Windlasses, 2<br>Whim, 1 | 5 | 4,000 | 153 |
| San Diego | 67,800 | 2,514,732 | ........ | 20,580 | 3,180 | 16,200 | 1,200 | 4 | 162 | 4 | 162 | Windlasses, 2 | ........ | ........ | 66 |
| San Luis Obispo | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Santa Barbara | ........ | 11,950 | ........ | 300 | ........ | 150 | 150 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 4 |
| Shasta | 21,202 | 1,396,200 | 3,375 | 189,895 | 68,383 | 116,700 | 4,812 | 6 | 143 | 3 | 81 | Water, 15 | 11 | 206 | 72 |
| Sierra | 82,872 | 5,400,810 | 33,190 | 634,898 | 180,500 | 447,890 | 6,508 | 34 | 658 | 20 | 414 | Water, 32 | 48 | 794 | 42 |
| Siskiyou | 38,162 | 3,407,703 | 2,275 | 80,795 | 21,645 | 54,925 | 4,225 | 7 | 121 | 8 | 324 | Hydraulic, 16<br>Water, 51<br>Overshot wheels, 2 | 18 | 369 | 77 |
| Stanislaus | 250 | 14,250 | ........ | 5,750 | 500 | 5,000 | 250 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 3 |
| Trinity | 54,250 | 2,499,701 | 19,998 | 110,910 | 24,900 | 85,100 | 910 | 9 | 217 | 21 | 212 | Water, 41<br>Hydraulic, 2 | 23 | 15 | 31 |
| Tulare | 200 | 62,600 | ........ | 5,300 | 300 | 5,000 | ........ | 2 | 56 | 2 | 28 | ........ | ........ | 40 | ........ |
| Tuolumne | 8,533 | 884,947 | 92 | 166,460 | 35,770 | 126,770 | 3,920 | 11 | 574 | 8 | 461 | Water, 8<br>Whim, 1<br>Windlasses, 2 | 11 | 441 | 35 |
| Ventura | 1,300 | 78,800 | ........ | 8,100 | 1,900 | 5,200 | 1,000 | 2 | 33 | 2 | 60 | Water, 1 | 2 | 13 | 15 |
| Yuba | ........ | 414,900 | ........ | 10,330 | 1,250 | 8,280 | 800 | ........ | ........ | ........ | ........ | Water, 9 | 8 | 218 | ........ |
| Undistributed placer gold. | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |

GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### COLORADO.

| COUNTIES. | Total amount of ore produced. (Short tons.) | Total amount of ore sold. (Short tons.) | Total amount of ore treated. (Short tons.) | ASSAY VALUE OF ORE SOLD. | | TOTAL BULLION VALUE. | | | ESTIMATED COINING VALUE OF BULLION PRODUCED FROM ORE SOLD. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gold. | Silver. | Grand total bullion. | Gold. | Silver. | Gold. | Silver. |
| Total | 852, 211 | 640, 917 | 148, 856 | $2, 501, 008 | $24, 968, 319 | $27, 641, 610 | $3, 883, 859 | $23, 757, 751 | $2, 375, 958 | $23, 719, 903 |
| Boulder | 24, 267 | 3, 486 | 12, 468 | 225, 854 | 101, 213 | 417, 782 | 310, 725 | 107, 057 | 214, 560 | 96, 150 |
| Chaffee | 28, 945 | 27, 049 | 720 | 227, 051 | 303, 705 | 550, 429 | 260, 627 | 289, 802 | 215, 699 | 288, 520 |
| Clear Creek | 34, 224 | 31, 250 | 3, 381 | 312, 296 | 2, 465, 499 | 2, 715, 003 | 372, 400 | 2, 342, 603 | 296, 681 | 2, 342, 224 |
| Conejos | 12 | 12 | | 3, 262 | 3, 278 | 6, 213 | 3, 099 | 3, 114 | 3, 099 | 3, 114 |
| Custer | 1, 514 | 452 | 50 | 20 | 61, 198 | 58, 904 | 19 | 58, 885 | 19 | 58, 139 |
| Dolores | 2, 702 | 2, 463 | | 40, 540 | 502, 834 | 516, 205 | 38, 512 | 477, 693 | 38, 512 | 477, 693 |
| Eagle | 8, 426 | 8, 416 | | 128, 056 | 368, 723 | 471, 941 | 121, 654 | 350, 287 | 121, 654 | 350, 287 |
| Fremont | | | | | | | | | | |
| Gilpin | 119, 553 | 29, 594 | 92, 824 | 614, 779 | 450, 279 | 1, 721, 747 | 1, 289, 420 | 432, 327 | 584, 040 | 427, 766 |
| Gunnison | 7, 494 | 4, 248 | 300 | 15, 681 | 188, 818 | 205, 882 | 16, 162 | 189, 720 | 14, 897 | 179, 377 |
| Hinsdale | 5, 411 | 389 | | 1, 572 | 21, 553 | 21, 969 | 1, 494 | 20, 475 | 1, 494 | 20, 475 |
| Lake | 365, 169 | 343, 336 | 6, 180 | 174, 367 | 8, 679, 211 | 8, 467, 151 | 221, 167 | 8, 245, 984 | 165, 649 | 8, 245, 250 |
| La Plata | 759 | 78 | 25 | 3, 570 | 2, 968 | 7, 611 | 4, 791 | 2, 820 | 3, 391 | 2, 820 |
| Larimer | 385 | | | | | | | | | |
| Ouray | 14, 363 | 14, 151 | 335 | 245, 188 | 1, 752, 444 | 1, 901, 131 | 236, 309 | 1, 664, 822 | 232, 929 | 1, 664, 822 |
| Park | 33, 766 | 23, 931 | 8, 075 | 34, 709 | 332, 288 | 449, 560 | 127, 886 | 321, 674 | 32, 974 | 315, 674 |
| Pitkin | 128, 150 | 118, 373 | 1, 500 | | 7, 726, 509 | 7, 362, 422 | 22, 238 | 7, 340, 184 | | 7, 340, 184 |
| Rio Grande | 172 | 96 | | 10, 664 | 800 | 10, 891 | 10, 131 | 760 | 10, 131 | 760 |
| Routt | | | | | | 18, 400 | 18, 400 | | | |
| Saguache | 626 | 490 | 120 | 3, 429 | 24, 312 | 28, 554 | 5, 458 | 23, 096 | 3, 258 | 23, 096 |
| San Juan | 15, 869 | 7, 094 | 3, 710 | 94, 035 | 490, 779 | 610, 362 | 142, 687 | 467, 675 | 89, 333 | 466, 240 |
| San Miguel | 15, 294 | 8, 847 | 6, 485 | 258, 417 | 842, 018 | 1, 107, 006 | 306, 328 | 800, 678 | 245, 496 | 799, 917 |
| Summit | 45, 110 | 17, 162 | 12, 683 | 107, 518 | 649, 890 | 892, 447 | 274, 352 | 618, 095 | 102, 142 | 617, 395 |
| Undistributed gold | | | | | | 100, 000 | 100, 000 | | | |

| COUNTIES. | COINING VALUE OF BULLION PRODUCED FROM ORE TREATED. | | PLACER BULLION. | | Total producing mines reported. | NUMBER OF MINES PRODUCING— | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gold. | Silver. | Gold. | Silver. | | Less than $1,000. | $1,000 to $10,000. | $10,000 to $50,000. | $50,000 to $100,000. | $100,000 to $250,000. | $250,000 to $500,000. | Over $500,000. |
| Total | $1, 294, 710 | $37, 574 | $113, 191 | $274 | 988 | 426 | 331 | 134 | 27 | 44 | 19 | 7 |
| Boulder | 94, 965 | 10, 907 | 1, 200 | | 90 | 54 | 22 | 12 | 2 | | | |
| Chaffee | 7, 056 | 1, 008 | 37, 872 | 274 | 31 | 17 | 10 | 2 | | 1 | 1 | |
| Clear Creek | 75, 219 | 379 | 500 | | 131 | 32 | 64 | 19 | 4 | 10 | 2 | |
| Conejos | | | | | 2 | | 2 | | | | | |
| Custer | | 746 | | | 18 | 9 | 7 | 2 | | | | |
| Dolores | | | | | 5 | | | 3 | | 1 | 1 | |
| Eagle | | | | | 19 | 4 | 7 | 5 | 2 | 1 | | |
| Fremont | | | | | | | | | | | | |
| Gilpin | 698, 230 | 4, 561 | 7, 150 | | 81 | 18 | 39 | 13 | 5 | 6 | | |
| Gunnison | 200 | 10, 343 | 1, 065 | | 102 | 81 | 13 | 8 | | | | |
| Hinsdale | | | | | 43 | 36 | 7 | | | | | |
| Lake | 55, 518 | 734 | | | 67 | 4 | 15 | 21 | 7 | 11 | 5 | 4 |
| La Plata | 1, 400 | | | | 34 | 33 | 1 | | | | | |
| Larimer | | | | | 4 | 4 | | | | | | |
| Ouray | 3, 380 | | | | 46 | 12 | 21 | 6 | 1 | 4 | 2 | |
| Park | 60, 880 | 6, 000 | 34, 032 | | 42 | 17 | 15 | 8 | 1 | 1 | | |
| Pitkin | 22, 238 | | | | 101 | 48 | 25 | 14 | 3 | 3 | 5 | 3 |
| Rio Grande | | | | | 2 | | 2 | | | | | |
| Routt | | | 18, 400 | | 2 | 1 | | 1 | | | | |
| Saguache | 2, 200 | | | | 20 | 8 | 12 | | | | | |
| San Juan | 53, 354 | 1, 435 | | | 49 | 12 | 24 | 10 | 2 | 1 | | |
| San Miguel | 58, 782 | 761 | 2, 050 | | 27 | 4 | 15 | 4 | | 1 | 3 | |
| Summit | 161, 288 | 700 | 10, 922 | | 72 | 32 | 30 | 6 | | 4 | | |
| Undistributed gold | | | | | | | | | | | | |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### COLORADO—Continued.

| COUNTIES. | EMPLOYÉS ABOVE GROUND. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | |
| | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. |
| Total | 330 | 781 | 1,505 | 16 | $4.33 | $3.80 | $2.91 | $1.70 | 234 | 254 | 237 | 212 |
| Boulder | 22 | 53 | 58 | ........ | 3.43 | 2.77 | 2.62 | ........ | 212 | 119 | 203 | ........ |
| Chaffee | 11 | 15 | 101 | 1 | 3.48 | 3.37 | 2.76 | 1.25 | 133 | 243 | 219 | 90 |
| Clear Creek | 34 | 56 | 92 | 1 | 3.75 | 3.18 | 2.78 | 2.00 | 256 | 299 | 265 | 313 |
| Conejos | 3 | 4 | 3 | ........ | 4.50 | 3.87 | 3.00 | ........ | 246 | 349 | 332 | ........ |
| Custer | 1 | 12 | 12 | ........ | 10.00 | 3.50 | 2.68 | ........ | 100 | 107 | 74 | ........ |
| Dolores | 2 | 5 | 10 | ........ | 4.50 | 3.90 | 3.10 | ........ | 195 | 237 | 312 | ........ |
| Eagle | 9 | 21 | 16 | ........ | 4.00 | 3.70 | 3.19 | ........ | 240 | 183 | 188 | ........ |
| Fremont | ........ | 2 | 4 | ........ | ........ | 3.00 | 2.50 | ........ | ........ | 52 | 52 | ........ |
| Gilpin | 22 | 70 | 119 | 4 | 3.94 | 3.15 | 2.63 | 1.37 | 278 | 309 | 287 | 177 |
| Gunnison | 17 | 24 | 24 | ........ | 3.90 | 3.33 | 2.86 | ........ | 164 | 142 | 213 | ........ |
| Hinsdale | 1 | 1 | 7 | ........ | 4.00 | 3.50 | 3.50 | ........ | 50 | 200 | 63 | ........ |
| Lake | 51 | 210 | 203 | 3 | 4.53 | 3.91 | 2.95 | 1.50 | 300 | 297 | 297 | 300 |
| La Plata | 1 | ........ | 2 | ........ | 2.50 | ........ | 3.50 | ........ | 60 | ........ | 118 | ........ |
| Larimer | 3 | ........ | 10 | 1 | 3.50 | ........ | 2.90 | 1.75 | 23 | ........ | 13 | 105 |
| Ouray | 6 | 59 | 160 | ........ | 4.92 | 3.91 | 3.02 | ........ | 248 | 241 | 257 | ........ |
| Park | 18 | 20 | 124 | 1 | 4.33 | 3.90 | 2.76 | 1.25 | 161 | 209 | 130 | 70 |
| Pitkin | 86 | 155 | 125 | 5 | 4.76 | 4.56 | 3.21 | 2.20 | 248 | 281 | 282 | 242 |
| Rio Grande | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Routt | 2 | ........ | 18 | ........ | 3.00 | ........ | 3.00 | ........ | 175 | ........ | 136 | ........ |
| Saguache | 2 | 2 | 8 | ........ | 3.00 | 3.50 | 2.62 | ........ | 65 | 72 | 76 | ........ |
| San Juan | 11 | 26 | 35 | ........ | 5.73 | 4.00 | 3.19 | ........ | 206 | 161 | 228 | ........ |
| San Miguel | 5 | 13 | 120 | ........ | 5.40 | 4.23 | 3.56 | ........ | 106 | 202 | 252 | ........ |
| Summit | 23 | 33 | 75 | ........ | 4.38 | 3.76 | 2.95 | ........ | 242 | 229 | 226 | ........ |
| Undistributed gold | ........ | ........ | 179 | ........ | ........ | ........ | 2.57 | ........ | ........ | ........ | 218 | ........ |

| COUNTIES. | EMPLOYÉS BELOW GROUND. | | | | | | | | | | | | Total number of mines. | Number of producing mines. | Mines working but not producing. | Number of mines idle. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | | | | | |
| | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | | | | |
| Total | 396 | 9,585 | 569 | 14 | $4.22 | $3.08 | $2.88 | $1.69 | 226 | 241 | 244 | 257 | 1,871 | 988 | 418 | 465 |
| Boulder | 22 | 449 | 20 | 1 | 3.83 | 2.64 | 2.23 | 1.15 | 164 | 156 | 188 | 42 | 222 | 90 | 60 | 72 |
| Chaffee | 12 | 227 | 57 | ........ | 4.13 | 2.99 | 2.60 | ........ | 239 | 212 | 256 | ........ | 76 | 31 | 26 | 19 |
| Clear Creek | 32 | 1,227 | 74 | ........ | 3.65 | 2.79 | 2.62 | ........ | 274 | 250 | 252 | ........ | 209 | 131 | 30 | 48 |
| Conejos | ........ | 30 | 2 | ........ | ........ | 2.93 | 2.75 | ........ | ........ | 167 | 74 | ........ | 13 | 2 | 9 | 2 |
| Custer | 8 | 110 | 2 | ........ | 3.94 | 2.89 | 2.00 | ........ | 114 | 117 | 81 | ........ | 44 | 18 | 8 | 18 |
| Dolores | 8 | 114 | 10 | ........ | 4.63 | 3.50 | 3.20 | ........ | 331 | 253 | 311 | ........ | 14 | 5 | 2 | 7 |
| Eagle | 13 | 193 | ........ | ........ | 3.92 | 3.07 | ........ | ........ | 277 | 247 | ........ | ........ | 29 | 19 | 5 | 5 |
| Fremont | 2 | 14 | ........ | ........ | 4.00 | 3.00 | ........ | ........ | 52 | 57 | ........ | ........ | 2 | ........ | 2 | ........ |
| Gilpin | 26 | 734 | 39 | 4 | 3.68 | 2.66 | 2.49 | 1.52 | 258 | 265 | 288 | 260 | 131 | 81 | 8 | 42 |
| Gunnison | 14 | 617 | 12 | ........ | 4.26 | 3.18 | 3.25 | ........ | 190 | 163 | 147 | ........ | 264 | 102 | 78 | 84 |
| Hinsdale | 25 | 167 | 2 | ........ | 4.24 | 2.47 | 3.75 | ........ | 93 | 97 | 210 | ........ | 85 | 43 | 23 | 19 |
| Lake | 61 | 1,828 | 77 | 6 | 4.24 | 3.01 | 2.93 | 1.83 | 285 | 274 | 202 | 304 | 93 | 67 | 15 | 11 |
| La Plata | 1 | 84 | ........ | ........ | 5.00 | 3.43 | ........ | ........ | 60 | 68 | ........ | ........ | 45 | 34 | 5 | 6 |
| Larimer | 1 | 18 | ........ | ........ | 2.50 | 2.43 | ........ | ........ | 50 | 73 | ........ | ........ | 15 | 4 | 7 | 4 |
| Ouray | 41 | 647 | 62 | ........ | 4.64 | 3.47 | 2.76 | ........ | 232 | 246 | 230 | ........ | 73 | 46 | 7 | 20 |
| Park | 10 | 231 | 11 | 1 | 3.85 | 3.11 | 3.00 | 1.50 | 224 | 185 | 204 | 60 | 83 | 42 | 12 | 29 |
| Pitkin | 43 | 1,518 | 98 | 2 | 4.34 | 3.36 | 3.03 | 2.00 | 258 | 353 | 290 | 313 | 166 | 101 | 63 | 2 |
| Rio Grande | 1 | 16 | ........ | ........ | 4.00 | 3.09 | ........ | ........ | 300 | 141 | ........ | ........ | 9 | 2 | 2 | 5 |
| Routt | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 2 | 2 | ........ | ........ |
| Saguache | 13 | 67 | 6 | ........ | 3.15 | 2.93 | 2.29 | ........ | 105 | 93 | 274 | ........ | 35 | 20 | 4 | 11 |
| San Juan | 20 | 393 | 20 | ........ | 4.78 | 3.45 | 3.42 | ........ | 163 | 167 | 272 | ........ | 78 | 49 | 6 | 23 |
| San Miguel | 22 | 392 | 59 | ........ | 5.39 | 3.67 | 3.51 | ........ | 241 | 171 | 182 | ........ | 36 | 27 | 3 | 6 |
| Summit | 21 | 509 | 18 | ........ | 4.26 | 3.03 | 2.89 | ........ | 220 | 185 | 120 | ........ | 147 | 72 | 43 | 32 |
| Undistributed gold | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### COLORADO—Continued.

| COUNTIES. | EXPENDITURES. | | | | | | | | | | VALUE OF MINING PROPERTY. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grand total of expenditures. | Grand total of wages. | Total wages paid in 1889. | Paid to contractors. | Office force. | | | | Value of supplies. | Other expenditures. | Total value of plant. | Value of buildings. | Value of railroads on surface. | Machinery. | Underground improvements. |
| | | | | | Males. | | Females. | | | | | | | | |
| | | | | | Number. | Wages paid. | Number. | Wages paid. | | | | | | | |
| Total | $13,834,332 | $10,114,682 | $9,339,875 | $400,772 | 219 | $368, 639 | 7 | $5, 396 | $2,559,705 | $1,159,945 | $137,881,531 | $1,235,853 | $137,562 | $2,961,167 | $26,316,640 |
| Boulder | 413, 694 | 269, 697 | 252, 714 | 8, 650 | 8 | 8, 333 | ...... | ...... | 78, 380 | 65, 617 | 8, 821, 846 | 65, 840 | 4, 135 | 130, 099 | 2, 037, 593 |
| Chaffee | 362, 497 | 298, 972 | 279, 001 | 2, 221 | 9 | 17, 750 | ...... | ...... | 55, 196 | 8, 329 | 3, 841, 855 | 56, 035 | 15, 285 | 147, 445 | 491, 201 |
| Clear Creek | 1, 385, 554 | 1, 131, 361 | 1, 071, 344 | 34, 729 | 11 | 25, 288 | ...... | ...... | 169, 133 | 85, 060 | 16, 023, 934 | 108, 845 | 25, 095 | 299, 077 | 3, 597, 608 |
| Conejos | 33, 850 | 28, 070 | 27, 300 | 770 | ...... | ......... | ...... | ...... | 3, 980 | 1, 800 | 88, 700 | 1, 110 | 100 | 1, 100 | 13, 010 |
| Custer | 70, 520 | 50, 332 | 47, 682 | ......... | 5 | 2, 650 | ...... | ...... | 19, 938 | 250 | 1, 451, 990 | 16, 400 | 3, 070 | 51, 400 | 254, 010 |
| Dolores | 186, 980 | 144, 592 | 139, 992 | ......... | 3 | 4, 600 | ...... | ...... | 33, 450 | 8, 938 | 3, 327, 150 | 10, 735 | 750 | 18, 450 | 276, 840 |
| Eagle | 241, 493 | 196, 448 | 190, 728 | 2, 320 | 3 | 3, 400 | ...... | ...... | 37, 852 | 7, 193 | 2, 826, 950 | 22, 225 | 14, 735 | 54, 300 | 572, 250 |
| Fremont | 8, 300 | 3, 625 | 3, 625 | ......... | ...... | ......... | ...... | ...... | 4, 675 | ......... | 75, 100 | 625 | 750 | 1, 300 | 64, 725 |
| Gilpin | 1, 161, 876 | 749, 471 | 664, 218 | 55, 503 | 19 | 29, 750 | ...... | ...... | 243, 388 | 169, 017 | 8, 158, 424 | 87, 425 | 2, 781 | 192, 587 | 2, 160, 543 |
| Gunnison | 369, 957 | 307, 376 | 278, 187 | 20, 539 | 4 | 8, 450 | 1 | 200 | 50, 250 | 12, 331 | 6, 347, 012 | 71, 265 | 7, 775 | 61, 988 | 1, 347, 093 |
| Hinsdale | 98, 924 | 69, 742 | 69, 742 | ......... | ...... | ......... | ...... | ...... | 19, 776 | 9, 406 | 1, 678, 570 | 22, 275 | 2, 650 | 12, 915 | 298, 060 |
| Lake | 3, 412, 364 | 2, 408, 118 | 2, 232, 860 | 41, 831 | 57 | 131, 555 | 1 | 1, 872 | 568, 963 | 435, 283 | 27, 348, 594 | 285, 480 | 1, 014 | 1, 060, 082 | 6, 290, 523 |
| La Plata | 33, 813 | 26, 482 | 26, 422 | 60 | ...... | ......... | ...... | ...... | 7, 331 | ......... | 908, 000 | 10, 200 | ......... | 1, 330 | 121, 027 |
| Larimer | 5, 469 | 4, 054 | 3, 934 | 120 | ...... | ......... | ...... | ...... | 617 | 798 | 128, 375 | 560 | ......... | 765 | 12, 295 |
| Ouray | 1, 290, 671 | 824, 492 | 755, 197 | 55, 078 | 9 | 14, 217 | ...... | ...... | 365, 501 | 100, 678 | 11, 724, 187 | 102, 427 | 15, 176 | 204, 361 | 1, 296, 215 |
| Park | 362, 133 | 265, 852 | 237, 144 | 16, 658 | 10 | 12, 050 | ...... | ...... | 63, 710 | 32, 571 | 5, 591, 520 | 63, 150 | 2, 280 | 126, 870 | 809, 440 |
| Pitkin | 2, 536, 661 | 1, 910, 320 | 1, 780, 045 | 48, 924 | 57 | 79, 031 | 3 | 2, 320 | 482, 648 | 143, 693 | 18, 112, 513 | 99, 321 | 6, 250 | 290, 450 | 3, 076, 969 |
| Rio Grande | 10, 760 | 8, 410 | 8, 150 | 260 | ...... | ......... | ...... | ...... | 1, 450 | 900 | 781, 250 | 3, 500 | 10, 000 | 3, 000 | 55, 700 |
| Routt | 12, 955 | 8, 369 | 8, 369 | ......... | ...... | ......... | ...... | ...... | 4, 354 | 232 | 138, 450 | 2, 575 | ......... | 4, 750 | ......... |
| Saguache | 35, 512 | 28. 363 | 27, 363 | 1, 000 | ...... | ......... | ...... | ...... | 4, 194 | 2, 955 | 467, 788 | 5, 650 | 400 | 8, 473 | 153, 625 |
| San Juan | 526, 667 | 351, 265 | 293, 011 | 54, 054 | 5 | 4, 200 | ...... | ...... | 128, 742 | 46, 660 | 5, 379, 550 | 70, 725 | 16, 778 | 43, 610 | 993, 782 |
| San Miguel | 587, 000 | 454, 980 | 420, 870 | 25, 100 | 8 | 8, 110 | 1 | 900 | 119, 571 | 12, 449 | 3, 887, 434 | 40, 650 | 1, 773 | 135, 650 | 904, 400 |
| Summit | 586, 682 | 474, 291 | 421, 977 | 32, 955 | 11 | 19, 255 | 1 | 104 | 96, 606 | 15, 785 | 10, 772, 339 | 88, 835 | 6, 765 | 111, 165 | 1, 489, 731 |
| Undistributed gold. | 100, 000 | 100, 000 | 100, 000 | ......... | ...... | ......... | ...... | ...... | ......... | ......... | ......... | ......... | ......... | ......... | ......... |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### COLORADO—Continued.

| COUNTIES. | VALUE OF MINING PROPERTY—continued. | | | VALUE OF MILL OR REDUCTION WORKS. | | | | MOTIVE POWER. | | | | | | | Number of animals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Boilers. | | Engines. | | Other power. | Motors. | | |
| | Mine supplies. | Mine proper. | Cash. | Total. | Buildings. | Machinery. | Supplies. | Number. | Horse power. | Number. | Horse power. | | Number. | Horse power. | |
| Total | $719,062 | $105,708,422 | $802,825 | $2,432,244 | $690,719 | $1,699,165 | $42,360 | 622 | 23,929 | 502 | 13,972 | ........ | 34 | 1,253 | 1,109 |
| Boulder | 9,505 | 6,556,674 | 18,000 | 257,750 | 76,350 | 181,200 | 200 | 48 | 1,795 | 36 | 859 | Horse whims, 27 | ........ | ........ | 38 |
| Chaffee | 32,269 | 3,019,120 | 80,500 | 26,200 | 4,000 | 21,650 | 550 | 8 | 342 | 3 | 129 | Horse whims, 2 | ........ | ........ | 25 |
| Clear Creek | 25,615 | 11,835,444 | 132,250 | 282,950 | 95,150 | 185,850 | 1,950 | 62 | 2,037 | 61 | 1,384 | Whims, 7<br>Windlasses, 6<br>Water, 2 | 6 | 270 | 120 |
| Conejos | 850 | 72,530 | ........ | ........ | ........ | ........ | ........ | 1 | 15 | 1 | 8 | ........ | ........ | ........ | ........ |
| Custer | 1,600 | 1,125,510 | ........ | 241,000 | 75,700 | 157,800 | 7,500 | 26 | 1,429 | 15 | 255 | Windlass, 1 | ........ | ........ | 6 |
| Dolores | 19,740 | 2,995,635 | 5,000 | ........ | ........ | ........ | ........ | 4 | 200 | 1 | 33 | ........ | 1 | 8 | 30 |
| Eagle | 3,800 | 2,148,315 | 11,325 | 12,000 | 1,500 | 10,500 | ........ | 22 | 628 | 13 | 272 | ........ | 1 | 60 | 8 |
| Fremont | 500 | 7,200 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | Windlass, 1 | ........ | ........ | ........ |
| Gilpin | 282,750 | 5,370,808 | 61,530 | 409,490 | 89,465 | 316,175 | 3,850 | 77 | 2,801 | 53 | 1,804 | Horse whims, 15<br>Horse whip, 1<br>Horse windlass, 1 | 6 | 194 | 70 |
| Gunnison | 80,235 | 4,767,296 | 11,360 | 57,050 | 15,000 | 42,000 | 50 | 15 | 343 | 12 | 250 | Windlasses, 41<br>Whims, 9<br>Tunnels, 15<br>Water, 3<br>Hoist, 1 | 1 | 10 | 46 |
| Hinsdale | 6,105 | 1,334,865 | 1,700 | 27,500 | 13,500 | 14,000 | ........ | 3 | 75 | 3 | 64 | Water, 2 | ........ | ........ | 48 |
| Lake | 52,978 | 19,548,433 | 110,084 | 316,115 | 78,104 | 228,651 | 9,360 | 172 | 7,744 | 152 | 6,265 | Hoisters, 2<br>Windlass, 1<br>Water wheel, 1<br>Tunnels, 4 | 1 | 36 | 85 |
| La Plata | 1,090 | 774,353 | ........ | ........ | ........ | ........ | ........ | 1 | 10 | ........ | ........ | Winzes, 2 | ........ | ........ | ........ |
| Larimer | 240 | 114,515 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | Windlass, 1<br>Water, 1 | 2 | 75 | 4 |
| Ouray | 97,650 | 9,919,194 | 89,164 | 13,500 | 5,000 | 6,000 | 2,500 | 30 | 1,151 | 14 | 344 | Whim, 1<br>Water, 1<br>Electric, 1<br>Gravity, 1 | 3 | 73 | 53 |
| Park | 17,040 | 4,561,740 | 11,000 | 145,000 | 35,300 | 108,200 | 1,500 | 20 | 612 | 10 | 645 | Water, 1<br>Windlasses, 2<br>Whims, 3<br>Tunnels, 2 | 2 | ........ | 41 |
| Pitkin | 26,320 | 14,432,087 | 181,116 | 73,139 | 30,350 | 40,139 | 2,650 | 78 | 2,539 | 81 | 782 | Windlasses, 54<br>Whims, 9<br>Drills, 7<br>Pumps, 6<br>Compressors, 2<br>Tunnel, 1 | 4 | 30 | 60 |
| Rio Grande | 1,150 | 707,900 | ........ | 4,700 | 2,000 | 2,500 | 200 | ........ | ........ | ........ | ........ | Windlass, 1 | ........ | ........ | ........ |
| Routt | 125 | 131,000 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | Water, 2 | ........ | ........ | ........ |
| Saguache | 1,125 | 298,515 | ........ | 27,050 | 11,000 | 16,050 | ........ | 5 | 208 | 4 | 161 | Whims, 6 | 1 | 2 | 4 |
| San Juan | 43,800 | 4,192,355 | 18,500 | 222,700 | 67,200 | 144,500 | 11,000 | 12 | 377 | 8 | 141 | Water, 2 | 5 | 495 | 79 |
| San Miguel | 3,990 | 2,799,675 | 1,296 | 105,500 | 22,500 | 82,000 | 1,000 | 9 | 550 | 6 | 78 | Tunnel, 1<br>Hydraulic, 1<br>Water, 1 | ........ | ........ | 360 |
| Summit | 10,585 | 8,995,258 | 70,000 | 210,600 | 68,600 | 141,950 | 50 | 29 | 1,073 | 29 | 498 | Whim, 1<br>Hydraulic, 2<br>Windlasses, 8<br>Tunnels, 2<br>Water, 2 | 1 | ........ | 32 |
| Undistributed gold | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |

GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

## IDAHO.

| COUNTIES. | BULLION PRODUCED FROM ORE SOLD OR TREATED IN 1889. | | EMPLOYÉS ABOVE GROUND. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | |
| | Gold. (Value.) | Silver. (Value.) | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. |
| Total | $1,984,159 | $4,056,482 | 128 | 354 | 964 | 2 | $4.64 | $4.04 | $3.04 | $1.25 | 211 | 203 | 187 | 285 |
| Ada | 3,307 | 65 | | | 6 | | | | 3.00 | | | | 187 | |
| Alturas | 13,869 | 465,946 | 20 | 74 | 57 | | 4.78 | 4.04 | 3.14 | | 158 | 170 | 156 | |
| Bear Lake | | | | | 2 | | | | 2.25 | | | | 55 | |
| Bingham | 20,236 | 41 | 10 | 51 | 153 | | 3.50 | 3.00 | 2.50 | | 120 | 120 | 86 | |
| Boise | 299,099 | 248,474 | 6 | 20 | 46 | | 4.00 | 4.65 | 3.47 | | 63 | 191 | 182 | |
| Cassia | 12,671 | 18,419 | 1 | 2 | 5 | | 4.72 | 3.97 | 3.01 | | 212 | 208 | 189 | |
| Custer | 164,475 | 728,627 | 9 | 21 | 76 | | 4.83 | 4.36 | 3.00 | | 215 | 242 | 265 | |
| Elmore | 314,132 | 27,016 | 5 | 29 | 61 | | 5.00 | 4.25 | 3.34 | | 104 | 177 | 109 | |
| Idaho | 242,356 | 12,001 | 5 | 15 | 39 | | 4.72 | 3.97 | 3.01 | | 212 | 208 | 189 | |
| Kootenai | 20,000 | 8,500 | 1 | 2 | 4 | | 4.72 | 3.97 | 3.01 | | 212 | 208 | 189 | |
| Latah | 1,000 | | | | 10 | | | | 2.00 | | | | 60 | |
| Lemhi | 377,868 | 130,099 | 15 | 24 | 170 | | 4.16 | 4.20 | 3.09 | | 304 | 149 | 190 | |
| Logan | 24,107 | 419,450 | 7 | 11 | 42 | 1 | 5.07 | 3.90 | 3.50 | 1.50 | 323 | 304 | 311 | 310 |
| Owyhee | 258,045 | 432,777 | 4 | 15 | 47 | | 5.00 | 4.33 | 3.27 | | 287 | 287 | 267 | |
| Shoshone | 222,712 | 1,557,022 | 34 | 86 | 224 | 1 | 5.14 | 4.33 | 3.13 | 1.00 | 252 | 267 | 234 | 260 |
| Washington | 10,282 | 8,045 | 11 | 4 | 22 | | 4.13 | 3.50 | 2.92 | | 160 | 250 | 55 | |

| COUNTIES. | EMPLOYÉS BELOW GROUND. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | |
| | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. |
| Total | 163 | 2,566 | 318 | | $4.79 | $3.59 | $3.10 | | 247 | 204 | 206 | |
| Ada | | | | | | | | | | | | |
| Alturas | 45 | 547 | 34 | | 4.57 | 3.57 | 3.26 | | 230 | 190 | 144 | |
| Bear Lake | | 4 | | | | 3.00 | | | | 55 | | |
| Bingham | 1 | 8 | 1 | | 4.91 | 3.50 | 3.10 | | 240 | 217 | 220 | |
| Boise | 11 | 159 | 6 | | 5.43 | 3.61 | 3.00 | | 306 | 257 | 200 | |
| Cassia | 1 | 11 | 1 | | 4.91 | 3.50 | 3.10 | | 240 | 217 | 220 | |
| Custer | 18 | 245 | 18 | | 4.91 | 3.60 | 3.00 | | 345 | 248 | 302 | |
| Elmore | 13 | 207 | 37 | | 4.60 | 3.49 | 3.00 | | 167 | 177 | 174 | |
| Idaho | 6 | 98 | 13 | | 4.91 | 4.00 | 3.10 | | 240 | 22 | 220 | |
| Kootenai | 1 | 10 | 1 | | 4.91 | 3.50 | 3.10 | | 240 | 217 | 220 | |
| Latah | | 30 | | | | 3.00 | | | | 100 | | |
| Lemhi | 19 | 321 | 44 | | 4.25 | 3.56 | 3.05 | | 242 | 194 | 133 | |
| Logan | 5 | 114 | 39 | | 5.10 | 3.50 | 3.23 | | 304 | 288 | 110 | |
| Owyhee | 10 | 157 | 21 | | 4.70 | 3.79 | 3.41 | | 134 | 196 | 350 | |
| Shoshone | 29 | 554 | 103 | | 5.29 | 3.57 | 3.00 | | 241 | 243 | 258 | |
| Washington | 4 | 101 | | | 4.00 | 3.75 | | | 330 | 94 | | |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### IDAHO—Continued.

| COUNTIES. | Total number of mines. | Number of producing mines. | Mines working but not producing. | Number of mines idle. | NUMBER OF MINES PRODUCING— Less than $1,000. | $1,000 to $10,000. | $10,000 to $50,000. | $50,000 to $100,000. | $100,000 to $250,000. | $250,000 to $500,000. | EXPENDITURES. Grand total of expenditures. | Grand total of wages. | Total wages paid in 1889. | Paid to contractors. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 536 | 421 | 69 | 46 | 209 | 147 | 42 | 12 | 8 | 3 | $4,870,484 | $3,686,362 | $3,331,151 | $194,257 |
| Ada |  |  |  |  |  |  |  |  |  |  | 2,552 | 1,900 | 1,740 | 97 |
| Alturas | 164 | 130 | 19 | 15 | 80 | 40 | 9 | 1 |  |  | 712,972 | 574,861 | 547,621 | 12,258 |
| Bear Lake | 3 | 1 | 1 | 1 | 1 |  |  |  |  |  | 1,232 | 1,057 | 907 | 150 |
| Bingham | 8 | 8 |  |  | 5 | 3 |  |  |  |  | 169,483 | 92,820 | 65,380 | 20,299 |
| Boise | 60 | 46 | 7 | 7 | 20 | 20 | 4 |  | 2 |  | 323,878 | 267,628 | 219,202 | 47,296 |
| Cassia | 10 | 10 |  |  | 5 | 5 |  |  |  |  | 23,267 | 17,401 | 15,856 | 886 |
| Custer | 67 | 44 | 18 | 5 | 18 | 17 | 5 | 1 | 2 | 1 | 411,247 | 342,729 | 341,553 | 1,176 |
| Elmore | 21 | 18 |  | 3 | 6 | 6 | 4 | 2 |  |  | 411,555 | 292,273 | 202,969 | 57,916 |
| Idaho | 21 | 21 |  |  | 10 | 8 | 2 | 1 |  |  | 190,717 | 142,706 | 130,076 | 7,239 |
| Kootenai | 9 | 9 |  |  | 5 | 4 |  |  |  |  | 21,277 | 15,915 | 14,503 | 810 |
| Latah | 7 | 1 | 2 | 4 |  | 1 |  |  |  |  | 11,200 | 10,200 | 10,200 |  |
| Lemhi | 50 | 48 |  | 2 | 25 | 17 | 4 | 2 |  |  | 583,689 | 449,443 | 394,899 | 13,149 |
| Logan | 12 | 9 | 1 | 2 | 5 | 1 | 2 |  |  | 1 | 314,112 | 233,090 | 218,679 | 14,411 |
| Owyhee | 55 | 31 | 17 | 7 | 12 | 11 | 5 | 3 |  |  | 285,854 | 216,928 | 210,878 | 1,210 |
| Shoshone | 42 | 38 | 4 |  | 13 | 11 | 7 | 2 | 4 | 1 | 1,344,494 | 974,866 | 905,596 | 15,916 |
| Washington | 7 | 7 |  |  | 4 | 3 |  |  |  |  | 62,955 | 52,536 | 51,092 | 1,444 |

| COUNTIES. | EXPENDITURES—continued. Office force. Males. Number. | Males. Wages paid. | Females. Number. | Females. Wages paid. | Value of supplies. | Other expenditures. | VALUE OF MINING PROPERTY. Total value of plant. | Value of buildings. | Value of railroads on surface. | Machinery. | Under ground improvements. | Mine supplies. | Mine proper. | Cash. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 104 | $160,261 | 9 | $693 | $889,958 | $294,164 | $44,194,594 | $1,012,677 | $283,183 | $928,439 | $8,295,875 | $415,634 | $33,154,216 | $104,570 |
| Ada |  | 72 |  |  | 469 | 174 | 21,798 | 437 | 185 | 499 | 3,672 | 201 | 16,740 | 64 |
| Alturas | 16 | 14,982 |  |  | 111,575 | 26,536 | 12,663,876 | 140,922 | 5,902 | 240,348 | 4,674,838 | 69,723 | 7,503,768 | 28,375 |
| Bear Lake |  |  |  |  | 175 |  | 13,260 | 175 |  |  | 3,075 | 10 | 10,000 |  |
| Bingham | 3 | 7,141 |  |  | 4,714 | 71,949 | 415,478 | 15,497 | 75,336 | 45,267 | 22,445 | 7,602 | 222,299 | 27,032 |
| Boise | 1 | 1,130 |  |  | 52,532 | 3,718 | 3,741,412 | 44,886 | 97,419 | 90,887 | 253,320 | 73,766 | 3,163,393 | 17,741 |
| Cassia |  | 658 |  | 1 | 4,277 | 1,589 | 198,608 | 3,978 | 1,684 | 4,547 | 33,464 | 1,828 | 152,520 | 587 |
| Custer |  |  |  |  | 68,030 | 488 | 2,645,412 | 32,854 | 5,880 | 43,218 | 687,813 | 7,718 | 1,867,929 |  |
| Elmore | 11 | 31,388 |  |  | 106,527 | 12,755 | 1,996,463 | 444,552 | 3,990 | 113,250 | 420,280 | 33,250 | 981,141 |  |
| Idaho | 4 | 5,382 |  | 9 | 35,026 | 12,985 | 1,922,776 | 32,809 | 13,764 | 37,531 | 282,922 | 14,939 | 1,536,016 | 4,795 |
| Kootenai |  | 601 |  | 1 | 3,908 | 1,454 | 181,605 | 3,639 | 1,541 | 4,159 | 30,607 | 1,672 | 139,450 | 537 |
| Latah |  |  |  |  | 1,000 |  | 47,000 |  |  |  |  | 2,000 | 45,000 |  |
| Lemhi | 29 | 40,713 | 9 | 682 | 89,549 | 44,697 | 4,133,072 | 75,242 | 974 | 18,384 | 471,416 | 45,072 | 3,521,984 |  |
| Logan |  |  |  |  | 63,139 | 17,883 | 1,500,140 | 19,260 |  | 50,290 | 317,790 | 16,585 | 1,088,725 | 7,490 |
| Owyhee | 2 | 4,840 |  |  | 60,470 | 8,456 | 5,485,608 | 101,398 | 30,250 | 170,858 | 500,735 | 43,929 | 4,638,438 |  |
| Shoshone | 38 | 53,354 |  |  | 280,444 | 89,184 | 7,382,149 | 93,328 | 45,175 | 105,627 | 489,169 | 64,488 | 6,566,413 | 17,949 |
| Washington |  |  |  |  | 8,123 | 2,296 | 1,845,937 | 3,700 | 1,083 | 3,574 | 104,329 | 32,851 | 1,700,400 |  |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### IDAHO—Continued.

| COUNTIES. | VALUE OF MILL OR REDUCTION WORKS. | | | | MOTIVE POWER. | | | | | | | Number of animals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | Buildings. | Machinery. | Supplies. | Boilers. | | Engines. | | Other power. | Motors. | | |
| | | | | | Number. | Horse power. | Number. | Horse power. | | Number. | Horse power. | |
| Total | $2,540,888 | $760,118 | $1,599,888 | $180,882 | 225 | 5,559 | 80 | 2,296 | | 67 | 3,274 | 273 |
| Ada | 1,191 | 341 | 763 | 87 | | 3 | | 2 | | | 1 | 1 |
| Alturas | 564,322 | 142,896 | 367,513 | 53,913 | 79 | 919 | 9 | 413 | Water, 1 | 5 | 79 | 36 |
| Bear Lake | | | | | | | | | | | | |
| Bingham | 7,277 | 2,084 | 4,661 | 532 | 1 | 20 | | 9 | Hydraulic, 1 | | 7 | 16 |
| Boise | 216,401 | 43,803 | 170,502 | 2,096 | 17 | 636 | 13 | 268 | | | | 17 |
| Cassia | 10,849 | 3,107 | 6,950 | 792 | 1 | 31 | | 14 | | | 11 | 1 |
| Custer | 2,205 | 735 | 1,470 | | 3 | 110 | | | Water, 1<br>Whim, 1 | 1 | 368 | 41 |
| Elmore | 232,750 | 59,850 | 142,310 | 30,590 | 21 | 1,184 | 21 | 340 | Hydraulic, 1<br>Water, 1 | 13 | 1,490 | 40 |
| Idaho | 88,648 | 25,386 | 56,785 | 6,477 | 7 | 249 | 3 | 114 | | 2 | 87 | 8 |
| Kootenai | 9,909 | 2,842 | 6,342 | 725 | 1 | 28 | | 13 | | | 10 | 1 |
| Latah | | | | | | | | | | | | |
| Lemhi | 439,449 | 198,940 | 226,455 | 14,054 | 19 | 273 | 10 | 418 | Hydraulic, 1 | 34 | 881 | 93 |
| Logan | 80,250 | 24,610 | 53,500 | 2,140 | 14 | 823 | 12 | 327 | Water, 1 | 2 | 56 | 6 |
| Owyhee | 238,128 | 70,785 | 131,285 | 36,058 | 19 | 756 | 7 | 99 | Water, 1<br>Windlass, 1<br>Whim, 1 | 2 | 24 | 5 |
| Shoshone | 598,969 | 179,324 | 388,032 | 31,613 | 43 | 527 | 5 | 279 | Water, 6 | 8 | 260 | 4 |
| Washington | 50,540 | 5,415 | 43,320 | 1,805 | | | | | Windlass, 1 | | | 4 |

### MICHIGAN.

| COUNTIES. | Ore produced. (Tons.) | Ore sold or treated. (Tons.) | BULLION PRODUCED FROM ORE SOLD OR TREATED IN 1889. | | EMPLOYÉS ABOVE GROUND. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | |
| | | | Gold. (Value.) | Silver. (Value.) | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. |
| Total | 31,865 | 31,865 | $87,040 | $18,885 | 2 | 7 | 32 | | $3.25 | $2.25 | $1.81 | | 312 | 350 | 319 | |
| Gogebic and Marquette. | 31,865 | 31,865 | 87,040 | 12,317 | 2 | 7 | 32 | | 3.25 | 2.25 | 1.81 | | 312 | 350 | 319 | |
| Houghton and Keweenaw. | | | | a6,568 | | | | | | | | | | | | |

| COUNTIES. | EMPLOYÉS BELOW GROUND. | | | | | | | | | | | | Total number of mines. | Number of producing mines. | Mines working but not producing. | Number of mines idle. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | | | | | |
| | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | | | | |
| Total | 1 | 40 | 13 | | $2.25 | $2.00 | $1.80 | | 310 | 310 | 310 | | 3 | 2 | 1 | |
| Gogebic and Marquette. | 1 | 40 | 13 | | 2.25 | 2.00 | 1.80 | | 310 | 310 | 310 | | 3 | 2 | 1 | |
| Houghton and Keweenaw. | | | | | | | | | | | | | | | | |

a Product of copper mines.

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### MICHIGAN—Continued.

| COUNTIES. | EXPENDITURES. | | | | | | | | | | VALUE OF MINING PROPERTY. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grand total of expenditures. | Grand total of wages. | Total wages paid in 1889. | Paid to contractors. | Office force. | | | | Value of supplies. | Other expenditures. | Total value of plant. | Value of buildings. | Value of railroads on surface. |
| | | | | | Males. | | Females. | | | | | | |
| | | | | | Number. | Wages paid. | Number. | Wages paid. | | | | | |
| Total | $99,183 | $56,198 | $45,096 | $10,447 | 2 | $655 | | | $9,152 | $33,833 | $676,212 | $11,600 | $87,406 |
| Gogebic and Marquette. | 99,183 | 56,198 | 45,096 | 10,447 | 2 | 655 | | | 9,152 | 33,833 | 676,212 | 11,600 | 87,406 |
| Houghton and Keweenaw. | | | | | | | | | | | | | |

| COUNTIES. | VALUE OF MINING PROPERTY—continued. | | | | | MOTIVE POWER. | | | | | | | Number of animals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Machinery. | Underground improvements. | Mine supplies. | Mine proper. | Cash. | Boilers. | | Engines. | | Other power. | Motors. | | |
| | | | | | | Number. | Horse power. | Number. | Horse power. | | Number. | Horse power. | |
| Total | $114,007 | $19,100 | $18,690 | $415,000 | $10,409 | 5 | 270 | 7 | 529 | | | | 6 |
| Gogebic and Marquette. | 114,007 | 19,100 | 18,690 | 415,000 | 10,409 | 5 | 270 | 7 | 529 | Water, 7 | | | 6 |
| Houghton and Keweenaw. | | | | | | | | | | | | | |

### MONTANA.

| COUNTIES. | Total amount of ore produced. (Short tons.) | Total amount of ore sold. (Short tons.) | Total amount of ore treated. (Short tons.) | ASSAY VALUE OF ORE SOLD. | | TOTAL BULLION VALUE. | | | ESTIMATED COINING VALUE OF BULLION PRODUCED FROM ORE SOLD. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gold. | Silver. | Grand total bullion. | Gold. | Silver. | Gold. | Silver. |
| Total | 528,518 | 109,242 | 353,261 | $403,537 | $3,964,438 | $20,608,287 | $3,139,327 | $17,468,960 | $383,446 | $3,766,218 |
| Beaverhead | 26,712 | | 26,900 | | | 904,656 | 35,602 | 869,054 | | |
| Deerlodge | 100,167 | 4,866 | 81,407 | 10,042 | 387,286 | 6,346,230 | 136,748 | 6,209,482 | 9,540 | 367,922 |
| Fergus | 14,171 | | 13,671 | | | 352,703 | 348,896 | 3,807 | | |
| Jefferson | 65,098 | 35,338 | 8,865 | 308,640 | 979,228 | 1,709,599 | 297,420 | 1,412,179 | 293,208 | 930,267 |
| Lewis and Clarke | 100,679 | 3,000 | 96,409 | 12,000 | 90,000 | 1,707,642 | 1,080,321 | 627,321 | 11,400 | 85,500 |
| Madison | 260 | 20 | 300 | 1,654 | 800 | 12,435 | 11,571 | 864 | 1,571 | 760 |
| Meagher | 1,484 | 171 | 1,200 | | 2,944 | 50,143 | 342 | 49,801 | | 2,797 |
| Missoula | 2,222 | 1,222 | | 5,000 | 119,100 | 117,895 | 4,750 | 113,145 | 4,750 | 113,145 |
| Park | 2,395 | | | | | | | | | |
| Silverbow | 215,330 | 64,625 | 124,509 | 66,201 | 2,385,080 | 7,896,388 | 377,509 | 7,518,879 | 62,977 | 2,265,827 |
| Undistributed | | | | | | 1,510,596 | 846,168 | 664,428 | | |

| COUNTIES. | COINING VALUE OF BULLION PRODUCED FROM ORE TREATED. | | PLACER BULLION. | | Total producing mines reported. | NUMBER OF MINES PRODUCING— | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gold. | Silver. | Gold. | Silver. | | Less than $1,000. | $1,000 to $10,000. | $10,000 to $50,000. | $50,000 to $100,000. | $100,000 to $250,000. | $250,000 to $500,000. | Over $500,000. |
| Total | $1,909,583 | $13,038,314 | $130 | | 75 | 13 | 21 | 13 | 3 | 9 | 8 | 8 |
| Beaverhead | 35,602 | 869,054 | | | 4 | | 1 | 2 | | | | 1 |
| Deerlodge | 127,208 | 5,841,560 | | | 13 | 1 | 2 | 4 | 2 | 1 | 1 | 2 |
| Fergus | 348,896 | 3,807 | | | 3 | 1 | 1 | | | | 1 | |
| Jefferson | 4,147 | 481,912 | 65 | | 13 | 2 | 5 | 2 | | 1 | 3 | |
| Lewis and Clarke | 1,068,921 | 541,821 | | | 5 | 1 | 1 | | | 1 | 1 | 1 |
| Madison | 10,000 | 104 | | | 2 | | 2 | | | | | |
| Meagher | 342 | 47,004 | | | 4 | 2 | 1 | 1 | | | | |
| Missoula | | | | | 6 | 2 | 3 | | | 1 | | |
| Park | | | | | | | | | | | | |
| Silverbow | 314,467 | 5,253,052 | 65 | | 25 | 4 | 5 | 4 | 1 | 5 | 2 | 4 |
| Undistributed | | | | | | | | | | | | |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### MONTANA—Continued.

| COUNTIES. | EMPLOYÉS ABOVE GROUND. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | |
| | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. |
| Total | 96 | 307 | 2, 613 | 5 | $5. 39 | $4. 14 | $3. 25 | $1. 40 | 286 | 296 | 287 | 300 |
| Beaverhead | 8 | 7 | 101 | ........ | 6. 43 | 4. 83 | 3. 00 | ........ | 228 | 260 | 221 | ........ |
| Deerlodge | 30 | 93 | 278 | ........ | 5. 29 | 4. 21 | 3. 15 | ........ | 317 | 334 | 326 | ........ |
| Fergus | 6 | 20 | 75 | ........ | 6. 00 | 4. 00 | 3. 00 | ........ | 220 | 175 | 120 | ........ |
| Jefferson | 12 | 14 | 107 | 1 | 4. 31 | 3. 79 | 3. 25 | 1. 00 | 250 | 236 | 295 | 254 |
| Lewis and Clarke | 12 | 49 | 129 | ........ | 6. 23 | 4. 50 | 3. 27 | ........ | 350 | 325 | 353 | ........ |
| Madison | ........ | 1 | 3 | ........ | ........ | 3. 00 | 3. 00 | ........ | ........ | 250 | 238 | ........ |
| Meagher | 1 | 1 | 2 | ........ | 4. 00 | 5. 00 | 3. 00 | ........ | 125 | 20 | 125 | ........ |
| Missoula | 4 | 3 | 8 | ........ | 4. 00 | 5. 00 | 2. 87 | ........ | 161 | 164 | 161 | ........ |
| Park | ........ | ........ | 2 | ........ | ........ | ........ | 3. 50 | ........ | ........ | ........ | 20 | ........ |
| Silverbow | 23 | 119 | 329 | 4 | 5. 43 | 3. 93 | 3. 49 | 1. 50 | 298 | 291 | 290 | 312 |
| Undistributed | ........ | ........ | 1, 579 | ........ | ........ | ........ | 3. 25 | ........ | ........ | ........ | 287 | ........ |

| COUNTIES. | EMPLOYÉS BELOW GROUND. | | | | | | | | | | | | Total number of mines. | Number of producing mines. | Mines working but not producing. | Number of mines idle. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | | | | | |
| | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | | | | |
| Total | 65 | 2, 552 | 254 | 5 | $5. 11 | $3. 48 | $3. 13 | $1. 75 | 303 | 295 | 292 | 324 | 114 | 75 | 26 | 13 |
| Beaverhead | 7 | 414 | 60 | ........ | 6. 00 | 3. 50 | 3. 00 | ........ | 300 | 293 | 290 | ........ | 4 | 4 | ........ | ........ |
| Deerlodge | 20 | 667 | 22 | ........ | 5. 03 | 3. 54 | 3. 34 | ........ | 322 | 330 | 317 | ........ | 25 | 13 | 9 | 3 |
| Fergus | ........ | 89 | 30 | ........ | ........ | 3. 50 | 3. 00 | ........ | ........ | 149 | 220 | ........ | 4 | 3 | 1 | ........ |
| Jefferson | 14 | 356 | 29 | ........ | 4. 82 | 3. 29 | 3. 11 | ........ | 313 | 275 | 251 | ........ | 21 | 13 | 8 | ........ |
| Lewis and Clarke | 3 | 146 | 61 | ........ | 6. 00 | 3. 47 | 3. 00 | ........ | 362 | 332 | 362 | ........ | 7 | 5 | 1 | 1 |
| Madison | 1 | 6 | ........ | ........ | 3. 00 | 3. 00 | ........ | ........ | ........ | ........ | ........ | ........ | 2 | 2 | ........ | ........ |
| Meagher | 1 | 14 | ........ | ........ | 4. 50 | 3. 50 | ........ | ........ | 280 | 222 | ........ | ........ | 10 | 4 | ........ | 6 |
| Missoula | 4 | 51 | 11 | ........ | 5. 42 | 3. 46 | 2. 82 | ........ | 168 | 176 | 171 | ........ | 8 | 6 | 2 | ........ |
| Park | 1 | 30 | ........ | ........ | 5. 00 | 3. 70 | ........ | ........ | 133 | 74 | ........ | ........ | 1 | ........ | 1 | ........ |
| Silverbow | 14 | 779 | 41 | 5 | 5. 00 | 3. 51 | 3. 58 | 1. 75 | 306 | 302 | 292 | 324 | 32 | 25 | 4 | 3 |
| Undistributed | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |

| COUNTIES. | EXPENDITURES. | | | | | | | | | | VALUE OF MINING PROPERTY. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grand total of expenditures. | Grand total of wages. | Total wages paid in 1889. | Paid to contractors. | Office force. | | | | Value of supplies. | Other expenditures. | Total value of plant. | Value of buildings. | Value of railroads on surface. | Machinery. | Underground improvements. |
| | | | | | Males. | | Females. | | | | | | | | |
| | | | | | No. | Wages paid. | No. | Wages paid. | | | | | | | |
| Total | $9, 259, 657 | $6, 123, 132 | $5, 881, 500 | $120, 567 | 52 | $120, 815 | 1 | $250 | $2,399,963 | $736, 562 | $53,256,396 | $494, 619 | $312, 150 | $1,642,241 | $11,352,908 |
| Beaverhead | 791, 517 | 610, 706 | 600, 979 | 9, 727 | ........ | ........ | ........ | ........ | 246 | 180, 565 | 3, 236, 675 | 58, 650 | 57, 500 | 118, 450 | 184, 000 |
| Deerlodge | 2, 107, 768 | 1, 263, 024 | 1, 212, 669 | 31, 126 | 12 | 24, 229 | ........ | ........ | 769, 006 | 70, 738 | 26, 599, 089 | 86, 979 | 152, 443 | 125, 920 | 6, 571, 008 |
| Fergus | 384, 778 | 131, 301 | 110, 220 | 19, 681 | 4 | 1, 400 | ........ | ........ | 64, 760 | 188, 717 | 316, 512 | 1, 000 | 512 | 7, 000 | 31, 500 |
| Jefferson | 721, 269 | 517, 582 | 476, 625 | 15, 854 | 8 | 24, 853 | 1 | 250 | 165, 713 | 37, 974 | 4, 634, 700 | 75, 300 | 35, 100 | 275, 000 | 556, 700 |
| Lewis and Clarke | 1, 001, 478 | 538, 942 | 487, 389 | 18, 000 | 12 | 33, 553 | ........ | ........ | 375, 280 | 87, 253 | 2, 847, 724 | 82, 655 | 62, 220 | 68, 168 | 135, 420 |
| Madison | 8, 656 | 7, 775 | 7, 775 | ........ | ........ | ........ | ........ | ........ | 800 | 81 | 1, 200, 000 | 2, 100 | ........ | 8, 100 | 31, 500 |
| Meagher | 14, 990 | 13, 415 | 13, 415 | ........ | ........ | ........ | ........ | ........ | 1, 350 | 225 | 777, 930 | 2, 400 | 200 | 850 | 38, 830 |
| Missoula | 50, 012 | 40, 612 | 37, 712 | 300 | 2 | 2, 600 | ........ | ........ | 9, 400 | ........ | 1, 063, 150 | 5, 200 | 1, 000 | 7, 075 | 50, 000 |
| Park | 10, 888 | 9, 438 | 9, 063 | 375 | ........ | ........ | ........ | ........ | 1, 300 | 150 | 659, 550 | 2, 050 | ........ | 1, 450 | 64, 600 |
| Silverbow | 2, 657, 705 | 1, 474, 741 | 1, 415, 057 | 25, 504 | 14 | 34, 130 | ........ | ........ | 1, 012, 108 | 170, 853 | 11, 921, 066 | 178, 285 | 3, 175 | 1, 030, 228 | 3, 689, 350 |
| Undistributed | 1, 510, 596 | 1, 510, 596 | 1, 510, 596 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### MONTANA—Continued.

| COUNTIES. | VALUE OF MINING PROPERTY—continued | | | VALUE OF MILL OR REDUCTION WORKS. | | | | MOTIVE POWER. | | | | | | | Number of animals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Boilers. | | Engines. | | Other power. | Motors. | | |
| | Mine supplies. | Mine proper. | Cash. | Total. | Buildings. | Machinery. | Supplies. | Number. | Horse power. | Number. | Horse power. | | Number. | Horse power. | |
| Total | $546,605 | $38,646,253 | $261,620 | $3,314,577 | $1,179,919 | $1,861,946 | $272,712 | 145 | 8,266 | 86 | 4,239 | | 5 | 158 | 265 |
| Beaverhead | 58,075 | 2,645,000 | 115,000 | 616,400 | 120,750 | 494,500 | 1,150 | 8 | 414 | 2 | 58 | Water, 2 | | 115 | 43 |
| Deerlodge | 50,804 | 19,579,359 | 32,576 | 760,019 | 192,256 | 476,357 | 91,406 | 20 | 965 | 11 | 580 | Whims, 2<br>Windlass, 1 | | | 118 |
| Fergus | 7,500 | 269,000 | | 74,000 | 25,200 | 41,300 | 7,500 | 4 | 280 | 3 | 180 | | | | 11 |
| Jefferson | 54,500 | 3,637,900 | 200 | 248,000 | 65,000 | 175,000 | 8,000 | 14 | 785 | 13 | 392 | Whims, 3 | | | 17 |
| Lewis and Clarke | 99,857 | 2,363,963 | 35,441 | 26,718 | 10,980 | 14,640 | 1,098 | 4 | 113 | 2 | 48 | Whim, 1<br>Water-wheel, 1 | | 18 | 7 |
| Madison | 2,000 | 1,156,300 | | 12,500 | 4,000 | 8,000 | 500 | 2 | 50 | 3 | 54 | | | | 6 |
| Meagher | 8,025 | 727,625 | | | | | | | | | | Whim, 1 | | | 1 |
| Missoula | 1,625 | 992,250 | 6,000 | 4,925 | 2,400 | 1,500 | 1,025 | 2 | 100 | 1 | 40 | Whims, 4<br>Windlass, 1 | | | 5 |
| Park | 5,775 | 585,675 | | | | | | 1 | 12 | | | Windlass, 1 | | | |
| Silverbow | 258,444 | 6,689,181 | 72,403 | 1,572,015 | 759,333 | 650,649 | 162,033 | 90 | 5,547 | 51 | 2,887 | Whim, 1 | 5 | 25 | 57 |
| Undistributed | | | | | | | | | | | | | | | |

### NEVADA.

| COUNTIES. | Total amount of ore produced. (Short tons.) | Total amount of ore sold. (Short tons.) | Total amount of ore treated. (Short tons.) | ASSAY VALUE OF ORE SOLD. | | TOTAL BULLION VALUE. | | | ESTIMATED COINING VALUE OF BULLION PRODUCED FROM ORE SOLD. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gold. | Silver. | Grand total bullion. | Gold. | Silver. | Gold. | Silver. |
| Total | 352,591 | 6,695 | 394,855 | $211,463 | $647,750 | $9,578,536 | $3,506,295 | $6,072,241 | $200,890 | $615,362 |
| Churchill | 475 | | 428 | | | 28,250 | 1,428 | 26,822 | | |
| Douglas | 210 | | 100 | | | 3,631 | 3,585 | 46 | | |
| Elko | 12,282 | 1,091 | 6,250 | 151,648 | 90,639 | 837,561 | 261,653 | 575,908 | 144,066 | 86,108 |
| Esmeralda | 16,128 | | 15,737 | | | 653,088 | 111,764 | 541,324 | | |
| Eureka | 16,360 | 3,021 | 15,161 | 48,093 | 168,959 | 1,239,243 | 178,946 | 1,060,297 | 45,688 | 160,509 |
| Humboldt | 684 | 124 | 150 | 207 | 10,570 | 11,730 | 447 | 11,283 | 197 | 10,042 |
| Lander | 10,441 | 455 | 9,986 | 200 | 111,622 | 194,147 | 88,106 | 106,041 | 190 | 106,041 |
| Lincoln | 4,152 | 876 | 3,263 | 6,942 | 43,582 | 158,326 | 65,546 | 92,780 | 6,595 | 41,403 |
| Lyon | 2,511 | | 52,960 | | | 249,135 | 103,251 | 145,884 | | |
| Nye | 3,217 | 830 | | 3,958 | 191,120 | 185,324 | 3,760 | 181,564 | 3,760 | 181,564 |
| Storey | 282,575 | | 288,154 | | | 5,739,049 | 2,510,998 | 3,228,051 | | |
| Washoe | 326 | | 326 | | | 11,046 | 10,896 | 150 | | |
| White Pine | 2,930 | 298 | 2,340 | 415 | 31,258 | 118,006 | 15,915 | 102,091 | 394 | 29,695 |
| Undistributed gold | | | | | | 150,000 | 150,000 | | | |

| COUNTIES. | COINING VALUE OF BULLION PRODUCED FROM ORE TREATED. | | PLACER BULLION. | | Total producing mines reported. | NUMBER OF MINES PRODUCING— | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gold. | Silver. | Gold. | Silver. | | Less than $1,000. | $1,000 to $10,000. | $10,000 to $50,000. | $50,000 to $100,000. | $100,000 to $250,000. | $250,000 to $500,000. | Over $500,000. |
| Total | $3,143,405 | $5,450,415 | $12,000 | $6,464 | 171 | 47 | 69 | 29 | 12 | 9 | 2 | 3 |
| Churchill | 1,428 | 26,822 | | | 3 | | 2 | 1 | | | | |
| Douglas | 3,585 | 46 | | | 2 | | 2 | | | | | |
| Elko | 117,587 | 489,800 | | | 3 | | 1 | 1 | 1 | | | |
| Esmeralda | 111,764 | 541,324 | | | 12 | | 3 | 7 | | 1 | 1 | |
| Eureka | 133,258 | 899,788 | | | 56 | 32 | 17 | 4 | | 2 | 1 | |
| Humboldt | 250 | 1,241 | | | 4 | 1 | 3 | | | | | |
| Lander | 87,916 | | | | 6 | 1 | 1 | 2 | 2 | | | |
| Lincoln | 58,951 | 51,377 | | | 8 | 1 | 4 | 2 | 1 | | | |
| Lyon | 103,251 | 145,884 | | | 10 | | 3 | 4 | 2 | 1 | | |
| Nye | | | | | 30 | 11 | 17 | | 2 | | | |
| Storey | 2,510,998 | 3,228,051 | | | 20 | | 7 | 3 | 3 | 4 | | 3 |
| Washoe | 10,896 | 150 | | | 2 | | 2 | | | | | |
| White Pine | 3,521 | 65,932 | 12,000 | 6,464 | 15 | 1 | 7 | 5 | 1 | 1 | | |
| Undistributed gold | | | | | | | | | | | | |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### NEVADA—Continued.

| COUNTIES. | EMPLOYÉS ABOVE GROUND. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | |
| | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. |
| Total | 83 | 261 | 779 | 1 | $5.07 | $4.56 | $3.22 | $2.00 | 304 | 298 | 270 | 365 |
| Churchill | 1 | 1 | 2 | ........ | 3.00 | 4.00 | 3.00 | ........ | 180 | 150 | 139 | ........ |
| Douglas | ........ | ........ | 1 | ........ | ........ | ........ | 3.00 | ........ | ........ | ........ | 225 | ........ |
| Elko | 5 | 54 | 56 | ........ | 4.60 | 4.47 | 3.50 | ........ | 331 | 283 | 299 | ........ |
| Esmeralda | 8 | 32 | 63 | ........ | 4.94 | 4.28 | 3.21 | ........ | 267 | 284 | 291 | ........ |
| Eureka | 9 | 17 | 125 | ........ | 5.72 | 4.03 | 3.20 | ........ | 295 | 238 | 308 | ........ |
| Humboldt | ........ | 4 | 10 | ........ | ........ | 3.63 | 2.00 | ........ | ........ | 215 | 198 | ........ |
| Lander | 5 | 11 | 23 | ........ | 6.90 | 3.96 | 2.13 | ........ | 354 | 199 | 190 | ........ |
| Lincoln | 6 | 19 | 43 | ........ | 4.71 | 3.97 | 2.47 | ........ | 344 | 352 | 297 | ........ |
| Lyon | 8 | 5 | 110 | 1 | 4.88 | 3.65 | 2.72 | 2.00 | 216 | 200 | 181 | 365 |
| Nye | 3 | 2 | ........ | ........ | 4.33 | 4.00 | ........ | ........ | 299 | 365 | ........ | ........ |
| Storey | 33 | 111 | 167 | ........ | 5.04 | 5.04 | 3.88 | ........ | 323 | 330 | 317 | ........ |
| Washoe | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| White Pine | 5 | 5 | 42 | ........ | 4.55 | 3.90 | 3.25 | ........ | 300 | 223 | 180 | ........ |
| Undistributed gold | ........ | ........ | 137 | ........ | ........ | ........ | 3.22 | ........ | ........ | ........ | 270 | ........ |

| COUNTIES. | EMPLOYÉS BELOW GROUND. | | | | | | | | | | | | Total number of mines. | Number of producing mines. | Mines working but not producing. | Number of mines idle. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | | | | | |
| | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | | | | |
| Total | 84 | 2,003 | 214 | 1 | $4.83 | $3.60 | $2.91 | $1.50 | 312 | 289 | 249 | 30 | 245 | 171 | 44 | 30 |
| Churchill | 1 | 6 | ........ | ........ | 4.00 | 3.00 | ........ | ........ | 360 | 340 | ........ | ........ | 3 | 3 | ........ | ........ |
| Douglas | ........ | 13 | ........ | ........ | ........ | 3.00 | ........ | ........ | ........ | 80 | ........ | ........ | 7 | 2 | 3 | 2 |
| Elko | 5 | 174 | ........ | ........ | 4.50 | 3.49 | ........ | ........ | 362 | 314 | ........ | ........ | 7 | 3 | 3 | 1 |
| Esmeralda | 14 | 224 | 16 | ........ | 4.83 | 3.09 | 3.09 | ........ | 283 | 280 | 321 | ........ | 19 | 12 | 3 | 4 |
| Eureka | 4 | 175 | 153 | ........ | 5.29 | 3.05 | 2.87 | ........ | 286 | 228 | 242 | ........ | 68 | 56 | 9 | 3 |
| Humboldt | 3 | 30 | 4 | ........ | 3.94 | 3.36 | 2.75 | ........ | 229 | 170 | 120 | ........ | 12 | 4 | 5 | 3 |
| Lander | 2 | 113 | 6 | ........ | 4.62 | 3.33 | 2.00 | ........ | 274 | 245 | 175 | ........ | 10 | 6 | 3 | 1 |
| Lincoln | 7 | 77 | 11 | ........ | 4.21 | 3.09 | 3.05 | ........ | 309 | 325 | 264 | ........ | 13 | 8 | 3 | 2 |
| Lyon | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 12 | 10 | ........ | 2 |
| Nye | 2 | 132 | 4 | 1 | 5.00 | 3.32 | 3.50 | 1.50 | 280 | 184 | 300 | 30 | 39 | 30 | 4 | 5 |
| Storey | 42 | 980 | 8 | ........ | 5.12 | 4.00 | 3.50 | ........ | 336 | 327 | 340 | ........ | 33 | 20 | 8 | 5 |
| Washoe | 1 | 13 | ........ | ........ | 4.00 | 3.54 | ........ | ........ | 300 | 217 | ........ | ........ | 3 | 2 | 1 | ........ |
| White Pine | 3 | 66 | 12 | ........ | 3.67 | 3.04 | 2.92 | ........ | 188 | 212 | 208 | ........ | 19 | 15 | 2 | 2 |
| Undistributed gold | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |

| COUNTIES. | EXPENDITURES. | | | | | | | | | | VALUE OF MINING PROPERTY. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grand total of expenditures. | Grand total of wages. | Total wages paid in 1889. | Paid to contractors. | Office force. | | | | Value of supplies. | Other expenditures. | Total value of plant. | Value of buildings. | Value of railroads on surface. | Machinery. | Underground improvements. |
| | | | | | Males. | | Females. | | | | | | | | |
| | | | | | No. | Wages paid. | No. | Wages paid. | | | | | | | |
| Total | $8,254,755 | $3,764,256 | $3,522,280 | $36,011 | 119 | $203,385 | 1 | $2,580 | $2,329,607 | $2,160,892 | $25,049,695 | $476,331 | $160,524 | $1,278,072 | $7,445,625 |
| Churchill | 16,260 | 12,260 | 12,260 | ........ | ........ | ........ | ........ | ........ | 4,000 | ........ | 31,000 | 1,000 | ........ | 1,000 | 6,000 |
| Douglas | 4,383 | 3,785 | 3,785 | ........ | 1 | ........ | ........ | ........ | 598 | ........ | 439,747 | 1,250 | ........ | 755 | 8,950 |
| Elko | 649,421 | 354,183 | 344,683 | ........ | 8 | 9,500 | ........ | ........ | 258,475 | 36,763 | 1,875,972 | 43,888 | 1,329 | 86,306 | 613,345 |
| Esmeralda | 542,939 | 338,776 | 315,417 | 4,144 | 10 | 19,215 | ........ | ........ | 145,472 | 58,691 | 1,743,048 | 47,500 | 2,300 | 80,950 | 353,200 |
| Eureka | 662,219 | 358,205 | 317,626 | 13,945 | 19 | 26,634 | ........ | ........ | 225,820 | 78,194 | 6,400,132 | 49,685 | 1,500 | 129,804 | 1,996,249 |
| Humboldt | 38,425 | 28,385 | 27,185 | ........ | 1 | 1,200 | ........ | ........ | 8,190 | 1,850 | 660,560 | 8,350 | 200 | 7,410 | 176,700 |
| Lander | 164,863 | 125,362 | 109,996 | 5,342 | 4 | 10,024 | ........ | ........ | 21,878 | 17,623 | 939,500 | 11,700 | 11,000 | 77,000 | 106,900 |
| Lincoln | 329,189 | 186,320 | 156,480 | 6,700 | 12 | 23,140 | ........ | ........ | 133,023 | 9,846 | 862,533 | 39,085 | 11,770 | 215,150 | 134,110 |
| Lyon | 211,504 | 91,413 | 84,813 | ........ | 4 | 6,600 | ........ | ........ | 99,125 | 20,966 | 201,700 | 2,400 | ........ | 4,975 | 25,000 |
| Nye | 136,303 | 107,753 | 97,493 | ........ | 8 | 10,260 | ........ | ........ | 19,370 | 9,180 | 2,741,535 | 24,275 | 200 | 20,850 | 561,045 |
| Storey | 5,192,975 | 1,911,893 | 1,809,844 | 5,880 | 48 | 93,589 | 1 | 2,580 | 1,369,246 | 1,911,836 | 7,757,378 | 230,810 | 12,100 | 635,637 | 3,282,626 |
| Washoe | 12,140 | 10,680 | 10,680 | ........ | ........ | ........ | ........ | ........ | 1,340 | 120 | 22,320 | 1,120 | ........ | ........ | ........ |
| White Pine | 144,134 | 85,241 | 82,018 | ........ | 4 | 3,223 | ........ | ........ | 43,070 | 15,823 | 1,374,270 | 15,268 | 120,125 | 18,235 | 181,500 |
| Undistributed gold | 150,000 | 150,000 | 150,000 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### NEVADA—Continued.

| COUNTIES. | VALUE OF MINING PROPERTY—continued. | | | VALUE OF MILL OR REDUCTION WORKS. | | | | MOTIVE POWER. | | | | | | | Number of animals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Boilers. | | Engines. | | Other power. | Motors. | | |
| | Mine supplies. | Mine proper. | Cash. | Total. | Buildings. | Machinery. | Supplies. | Number. | Horse power. | Number. | Horse power. | | Number. | Horse power. | |
| Total | $348,854 | $15,202,039 | $138,250 | $1,818,176 | $458,881 | $1,187,352 | $171,943 | 189 | 9,283 | 139 | 11,048 | .......... | 34 | 705 | 233 |
| Churchill | 1,500 | 21,500 | .......... | 23,500 | 2,000 | 18,000 | 3,500 | 1 | 60 | 1 | 16 | .......... | ...... | ...... | 24 |
| Douglas | 1,127 | 427,550 | 115 | 3,608 | 1,300 | 2,100 | 208 | 3 | 22 | 2 | 18 | Windlass, 1 | ...... | ...... | 2 |
| Elko | 13,750 | 1,117,350 | 4 | 375,500 | 126,000 | 246,500 | 3,000 | 9 | 425 | 6 | 293 | Whim, 1 | ...... | ...... | 2 |
| Esmeralda | 9,898 | 1,231,410 | 17,790 | 252,207 | 98,546 | 124,859 | 28,802 | 9 | 445 | 7 | 553 | Whims, 2 | 1 | 132 | 40 |
| Eureka | 98,637 | 4,118,900 | 5,357 | 323,693 | 53,400 | 240,593 | 29,700 | 23 | 742 | 20 | 774 | Air compressor, 1<br>Hand, 2<br>Whims, 9<br>Whips, 6 | 15 | 17 | 37 |
| Humboldt | 135,900 | 329,500 | 2,500 | 39,225 | 10,125 | 26,600 | 2,500 | 2 | 74 | 3 | 86 | .......... | 3 | ...... | 7 |
| Lander | 8,740 | 724,160 | .......... | 74,632 | 12,800 | 51,200 | 10,632 | 7 | 540 | 6 | 233 | .......... | 1 | 200 | 14 |
| Lincoln | 16,096 | 411,405 | 34,917 | 177,153 | 36,200 | 110,000 | 30,953 | 13 | 450 | 8 | 250 | Windlasses, 2<br>Hand, 1 | ...... | ...... | 25 |
| Lyon | 1,500 | 167,825 | .......... | 76,293 | 17,800 | 39,300 | 19,193 | 3 | 120 | 3 | 108 | Hand, 1<br>Whim, 1<br>Water, 5 | 4 | 275 | 35 |
| Nye | 8,425 | 2,123,740 | 3,000 | 175,100 | 49,200 | 121,800 | 4,100 | 15 | 655 | 6 | 499 | Whims, 4<br>Windlass, 1<br>Water, 1 | 3 | 4 | 13 |
| Storey | 40,185 | 3,481,707 | 74,313 | 165,105 | 27,200 | 122,900 | 15,005 | 95 | 5,382 | 70 | 7,576 | Air compressors, 4<br>Water, 6<br>Whim, 1 | 6 | 76 | 20 |
| Washoe | 200 | 21,000 | .......... | 5,000 | 2,000 | 3,000 | ...... | ...... | ...... | ...... | ...... | Whim, 1 | ...... | ...... | 4 |
| White Pine | 12,896 | 1,025,992 | 254 | 127,160 | 22,310 | 80,500 | 24,350 | 9 | 368 | 7 | 642 | Whim, 1<br>Water, 4<br>Windlasses, 4 | 1 | 1 | 10 |
| Undistributed gold | .......... | .......... | .......... | .......... | .......... | .......... | .......... | ...... | ...... | ...... | ...... | .......... | ...... | ...... | ...... |

### NEW MEXICO.

| COUNTIES. | Total amount of ore produced. (Short tons.) | Total amount of ore sold. (Short tons.) | Total amount of ore treated. (Short tons.) | ASSAY VALUE OF ORE SOLD. | | TOTAL BULLION VALUE. | | | ESTIMATED COINING VALUE OF BULLION PRODUCED FROM ORE SOLD. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gold. | Silver. | Grand total bullion. | Gold. | Silver. | Gold. | Silver. |
| Total | 105,870 | 40,501 | 58,486 | $137,562 | $1,288,485 | $2,433,233 | $815,655 | $1,617,578 | $130,684 | $1,224,062 |
| Bernalillo | 769 | .......... | 650 | .......... | .......... | 6,740 | 6,740 | .......... | .......... | .......... |
| Colfax | 1,051 | .......... | 476 | .......... | .......... | 23,221 | 23,166 | 55 | .......... | .......... |
| Donna Ana | 7,337 | 7,275 | .......... | .......... | 76,868 | 73,025 | .......... | 73,025 | .......... | 73,025 |
| Grant | 63,428 | 17,483 | 44,078 | 31,052 | 346,680 | 1,121,237 | 436,025 | 685,212 | 29,500 | 329,346 |
| Lincoln | 6,550 | .......... | 5,800 | .......... | .......... | 55,208 | 52,100 | 3,108 | .......... | .......... |
| Rio Arriba | 600 | .......... | 600 | .......... | .......... | 5,340 | 5,240 | 100 | .......... | .......... |
| San Miguel | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... |
| Santa Fe | 4,065 | 2,907 | 643 | 17,600 | 53,175 | 92,216 | 41,694 | 50,522 | 16,720 | 50,517 |
| Sierra | 11,461 | 7,045 | 3,589 | 88,766 | 740,562 | 844,081 | 135,933 | 708,148 | 84,328 | 703,534 |
| Socorro | 10,609 | 5,791 | 2,650 | 144 | 71,200 | 112,165 | 14,757 | 97,408 | 136 | 67,640 |
| Undistributed gold | .......... | .......... | .......... | .......... | .......... | 100,000 | 100,000 | .......... | .......... | .......... |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### NEW MEXICO—Continued.

| COUNTIES. | COINING VALUE OF BULLION PRODUCED FROM ORE TREATED. | | PLACER BULLION. | | Total producing mines reported. | NUMBER OF MINES PRODUCING— | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gold. | Silver. | Gold. | Silver. | | Less than $1,000. | $1,000 to $10,000. | $10,000 to $50,000. | $50,000 to $100,000. | $100,000 to $250,000. | $250,000 to $500,000. | Over $500,000. |
| Total | $541,380 | $393,516 | $43,591 | ........ | 129 | 28 | 56 | 34 | 7 | 3 | 1 | ........ |
| Bernalillo | 6,740 | ........ | ........ | ........ | 3 | 1 | 2 | ........ | ........ | ........ | ........ | ........ |
| Colfax | 7,715 | 55 | 15,451 | ........ | 6 | 2 | 3 | 1 | ........ | ........ | ........ | ........ |
| Donna Ana | ........ | ........ | ........ | ........ | 3 | 1 | 1 | ........ | 1 | ........ | ........ | ........ |
| Grant | 401,525 | 355,866 | 5,000 | ........ | 55 | 12 | 24 | 15 | 2 | 2 | ........ | ........ |
| Lincoln | 52,100 | 3,108 | ........ | ........ | 4 | ........ | 2 | 2 | ........ | ........ | ........ | ........ |
| Rio Arriba | 2,100 | 100 | 3,140 | ........ | 4 | 2 | 2 | ........ | ........ | ........ | ........ | ........ |
| San Miguel | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Santa Fe | 19,974 | 5 | 5,000 | ........ | 11 | 2 | 7 | 1 | 1 | ........ | ........ | ........ |
| Sierra | 36,605 | 4,614 | 15,000 | ........ | 29 | 3 | 11 | 10 | 3 | 1 | 1 | ........ |
| Socorro | 14,621 | 29,768 | ........ | ........ | 14 | 5 | 4 | 5 | ........ | ........ | ........ | ........ |
| Undistributed gold | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |

| COUNTIES. | EMPLOYÉS ABOVE GROUND. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | |
| | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. |
| Total | 45 | 90 | 520 | 13 | $4.09 | $3.50 | $2.31 | $1.27 | 169 | 193 | 204 | 166 |
| Bernalillo | ........ | 2 | 4 | ........ | ........ | 2.00 | 3.00 | ........ | ........ | 60 | 50 | ........ |
| Colfax | 7 | ........ | 41 | ........ | 3.93 | ........ | 2.23 | ........ | 151 | ........ | 186 | ........ |
| Donna Ana | 2 | 2 | 6 | ........ | 4.00 | 4.00 | 3.00 | ........ | 180 | 300 | 300 | ........ |
| Grant | 13 | 44 | 93 | 8 | 4.39 | 3.32 | 2.09 | 1.19 | 163 | 170 | 208 | 223 |
| Lincoln | 6 | 4 | 19 | 2 | 3.08 | 3.38 | 2.55 | 1.00 | 115 | 133 | 138 | 30 |
| Rio Arriba | 1 | 4 | 6 | ........ | 2.00 | 3.50 | 1.50 | ........ | 200 | 284 | 241 | ........ |
| San Miguel | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Santa Fe | 3 | 10 | 64 | ........ | 3.83 | 3.90 | 2.14 | ........ | 214 | 242 | 248 | ........ |
| Sierra | 7 | 20 | 49 | 1 | 4.18 | 3.76 | 2.64 | 2.00 | 211 | 219 | 194 | 42 |
| Socorro | 6 | 4 | 26 | 2 | 5.07 | 3.88 | 2.71 | 1.50 | 178 | 176 | 165 | 137 |
| Undistributed gold | ........ | ........ | 212 | ........ | ........ | ........ | 2.31 | ........ | ........ | ........ | 204 | ........ |

| COUNTIES. | EMPLOYÉS BELOW GROUND. | | | | | | | | | | | | Total number of mines. | Number of producing mines. | Mines working but not producing. | Number of mines idle. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | | | | | |
| | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | | | | |
| Total | 48 | 1,202 | 154 | 12 | $4.15 | $3.15 | $2.26 | $1.21 | 233 | 214 | 228 | 211 | 250 | 129 | 57 | 64 |
| Bernalillo | ........ | 21 | 1 | ........ | ........ | 2.48 | 3.00 | ........ | ........ | 59 | 6 | ........ | 5 | 3 | 1 | 1 |
| Colfax | 2 | 13 | ........ | ........ | 4.50 | 2.75 | ........ | ........ | 265 | 219 | ........ | ........ | 8 | 6 | 2 | ........ |
| Donna Ana | 1 | 45 | 4 | ........ | 4.00 | 3.40 | 3.00 | ........ | 300 | 280 | 300 | ........ | 4 | 3 | ........ | 1 |
| Grant | 15 | 440 | 86 | 12 | 3.93 | 3.03 | 2.16 | 1.21 | 244 | 230 | 206 | 211 | 89 | 55 | 11 | 23 |
| Lincoln | 5 | 69 | 3 | ........ | 3.60 | 2.93 | 2.50 | ........ | 185 | 168 | 312 | ........ | 37 | 4 | 18 | 15 |
| Rio Arriba | ........ | 2 | ........ | ........ | ........ | 2.00 | ........ | ........ | ........ | 350 | ........ | ........ | 4 | 4 | ........ | ........ |
| San Miguel | ........ | 6 | ........ | ........ | ........ | 3.00 | ........ | ........ | ........ | 47 | ........ | ........ | 3 | ........ | 2 | 1 |
| Santa Fe | 5 | 85 | 6 | ........ | 3.82 | 3.10 | 2.50 | ........ | 264 | 253 | 312 | ........ | 11 | 11 | ........ | ........ |
| Sierra | 13 | 385 | 42 | ........ | 4.69 | 3.38 | 2.41 | ........ | 235 | 211 | 243 | ........ | 69 | 29 | 19 | 21 |
| Socorro | 7 | 136 | 12 | ........ | 4.14 | 3.08 | 2.00 | ........ | 200 | 179 | 261 | ........ | 20 | 14 | 4 | 2 |
| Undistributed gold | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |

GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

NEW MEXICO—Continued.

| COUNTIES. | EXPENDITURES. | | | | | | | | | | VALUE OF MINING PROPERTY. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grand total of expenditures. | Grand total of wages. | Total wages paid in 1889. | Paid to contractors. | Office force. | | | | Value of supplies. | Other expenditures. | Total value of plant. | Value of buildings. | Value of railroads on surface. | Machinery. | Underground improvements. |
| | | | | | Males. | | Females. | | | | | | | | |
| | | | | | No. | Wages paid. | No. | Wages paid. | | | | | | | |
| Total | $1, 730, 126 | $1,333,462 | $1, 226, 857 | $55, 383 | 30 | $49, 454 | 2 | $1, 768 | $270, 706 | $125, 958 | $18, 268, 499 | $256, 349 | $15, 000 | $881, 045 | $2, 413, 506 |
| Bernalillo | 6, 431 | 3, 598 | 3, 598 | | | | | | 2, 783 | 80 | 135, 040 | 2, 500 | | 1, 770 | 12, 000 |
| Colfax | 50, 818 | 34, 448 | 31, 298 | 2, 050 | 1 | 1, 100 | | | 7, 491 | 8, 879 | 730, 250 | 16, 050 | 100 | 75, 500 | 50, 000 |
| Donna Ana | 64, 690 | 57, 580 | 57, 380 | 200 | | | | | 6, 610 | 500 | 227, 150 | 1, 300 | | 2, 150 | 40, 000 |
| Grant | 569, 452 | 433, 493 | 408, 314 | 13, 234 | 7 | 11, 945 | | | 119, 617 | 16, 342 | 7, 891, 271 | 98, 730 | 8, 375 | 159, 160 | 1, 090, 658 |
| Lincoln | 63, 648 | 55, 935 | 52, 335 | | 2 | 3, 600 | | | 5, 115 | 2, 598 | 906, 627 | 4, 100 | 700 | 8, 450 | 130, 790 |
| Rio Arriba | 19, 900 | 8, 400 | 8, 400 | | | | | | 7, 877 | 3, 623 | 138, 440 | 1, 500 | 100 | 7, 500 | 21, 000 |
| San Miguel | 1, 790 | 1, 440 | 1, 440 | | | | | | 350 | | 15, 000 | 300 | 200 | | 1, 000 |
| Santa Fe | 151, 028 | 120, 050 | 116, 892 | 158 | 1 | 3, 000 | | | 17, 400 | 13, 578 | 1, 822, 575 | 20, 500 | 25 | 508, 275 | 42, 800 |
| Sierra | 546, 630 | 410, 222 | 345, 676 | 39, 741 | 14 | 24, 805 | | | 69, 957 | 66, 451 | 5, 220, 946 | 62, 619 | 4, 500 | 89, 140 | 904, 708 |
| Socorro | 155, 709 | 108, 296 | 101, 524 | | 5 | 5, 004 | 2 | 1, 768 | 33, 506 | 13, 907 | 1, 181, 200 | 48, 750 | 1, 000 | 29, 100 | 120, 550 |
| Undistributed gold | 100, 000 | 100, 000 | 100, 000 | | | | | | | | | | | | |

| COUNTIES. | VALUE OF MINING PROPERTY—continued. | | | VALUE OF MILL OR REDUCTION WORKS. | | | | MOTIVE POWER. | | | | | | | Number of animals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mine supplies. | Mine proper. | Cash. | Total. | Buildings. | Machinery. | Supplies. | Boilers. | | Engines. | | Other power. | Motors. | | |
| | | | | | | | | Number. | Horse power. | Number. | Horse power. | | Number. | Horse power. | |
| Total | $312, 822 | $14,273,655 | $116, 122 | $1, 079, 910 | $201, 540 | $829, 150 | $49, 220 | 100 | 3, 773 | 62 | 1, 912 | | | | 200 |
| Bernalillo | 120 | 118, 650 | | 5, 100 | 1, 100 | 4, 000 | | 1 | 20 | 1 | 20 | | | | 9 |
| Colfax | 2, 400 | 586, 200 | | 13, 750 | 2, 700 | 11, 000 | 50 | 7 | 432 | 3 | 32 | | | | |
| Donna Ana | 300 | 183, 400 | | | | | | | | | | Whim, 1 | | | 1 |
| Grant | 275, 275 | 6, 245, 073 | 14, 000 | 667, 033 | 164, 190 | 469, 650 | 33, 193 | 49 | 1, 847 | 33 | 1, 211 | Windlasses, 3<br>Whims, 5 | | | 127 |
| Lincoln | 1, 427 | 761, 160 | | 30, 000 | 2, 500 | 25, 000 | 2, 500 | 5 | 240 | 6 | 91 | | | | 10 |
| Rio Arriba | 900 | 107, 400 | 40 | 9, 100 | 1, 400 | 7, 500 | 200 | 4 | 73 | | | | | | 4 |
| San Miguel | | 13, 500 | | 20, 300 | 300 | 20, 000 | | 1 | 80 | | | | | | 6 |
| Santa Fe | 1, 025 | 1, 249, 950 | | | | | | 4 | 111 | 1 | 80 | Whims, 2 | | | 20 |
| Sierra | 28, 075 | 4, 047, 822 | 84, 082 | 273, 800 | 14, 300 | 257, 000 | 2, 500 | 27 | 900 | 16 | 433 | Whims, 3 | | | 15 |
| Socorro | 3, 300 | 960, 500 | 18, 000 | 60, 827 | 15, 050 | 35, 000 | 10, 777 | 2 | 70 | 2 | 45 | Windlass, 1<br>Whims, 2 | | | 8 |
| Undistributed gold | | | | | | | | | | | | | | | |

## OREGON.

| COUNTIES. | Total amount of ore produced. (Short tons.) | Total amount of ore sold. (Short tons.) | Total amount of ore treated. (Short tons.) | ASSAY VALUE OF ORE SOLD. | | TOTAL BULLION VALUE. | | | ESTIMATED COINING VALUE OF BULLION PRODUCED FROM ORE SOLD. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gold. | Silver. | Total. | Gold. | Silver. | Gold. | Silver. |
| Total | 32, 809 | 387 | 26, 698 | $14, 361 | $19, 768 | $987, 691 | $964, 309 | $23, 382 | $13, 642 | $18, 780 |
| Baker | 9, 598 | 40 | 8, 584 | 5, 084 | 318 | 308, 719 | 307, 097 | 1, 622 | 4, 830 | 302 |
| Columbia | | | | | | | | | | |
| Coos | | | | | | 21, 327 | 21, 327 | | | |
| Crook | 3 | 3 | | 316 | | 300 | 300 | | 300 | |
| Curry | | | | | | 4, 879 | 4, 879 | | | |
| Douglas | | | | | | 2, 500 | 2, 500 | | | |
| Grant | 2, 435 | 300 | 695 | 6, 500 | 19, 040 | 93, 553 | 73, 613 | 19, 940 | 6, 175 | 18, 088 |
| Jackson | 490 | | 80 | | | 31, 438 | 31, 433 | 5 | | |
| Josephine | 631 | 41 | 48 | 2, 111 | 410 | 49, 915 | 49, 525 | 390 | 2, 005 | 390 |
| Lane | | | | | | | | | | |
| Linn | | | | | | | | | | |
| Malheur | 130 | | 130 | | | 38, 350 | 38, 350 | | | |
| Union | 19, 522 | 3 | 17, 161 | 350 | | 236, 710 | 235, 285 | 1, 425 | 332 | |
| Undistributed gold | | | | | | 200, 000 | 200, 000 | | | |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### OREGON—Continued.

| COUNTIES. | COINING VALUE OF BULLION PRODUCED FROM ORE TREATED. | | PLACER BULLION. | | Total producing mines reported. | NUMBER OF MINES PRODUCING— | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gold. | Silver. | Gold. | Silver. | | Less than $1,000. | $1,000 to $10,000. | $10,000 to $50,000. | $50,000 to $100,000. | $100,000 to $250,000. | $250,000 to $500,000. | Over $500,000. |
| Total | $294,451 | $4,602 | $456,216 | .......... | 200 | 122 | 63 | 13 | 2 | .......... | .......... | .......... |
| Baker | 136,063 | 1,320 | 166,204 | .......... | 34 | 9 | 19 | 5 | 1 | .......... | .......... | .......... |
| Columbia | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... |
| Coos | .......... | .......... | 21,327 | .......... | 25 | 24 | 1 | .......... | .......... | .......... | .......... | .......... |
| Crook | .......... | .......... | .......... | .......... | 1 | 1 | .......... | .......... | .......... | .......... | .......... | .......... |
| Curry | .......... | .......... | 4,879 | .......... | 6 | 6 | .......... | .......... | .......... | .......... | .......... | .......... |
| Douglas | .......... | .......... | 2,500 | .......... | 5 | 5 | .......... | .......... | .......... | .......... | .......... | .......... |
| Grant | 12,196 | 1,852 | 55,242 | .......... | 31 | 10 | 19 | 2 | .......... | .......... | .......... | .......... |
| Jackson | 5,758 | 5 | 25,675 | .......... | 24 | 18 | 5 | 1 | .......... | .......... | .......... | .......... |
| Josephine | 1,400 | .......... | 46,120 | .......... | 36 | 23 | 13 | .......... | .......... | .......... | .......... | .......... |
| Lane | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... |
| Linn | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... |
| Malheur | 1,350 | .......... | 37,000 | .......... | 22 | 20 | 2 | .......... | .......... | .......... | .......... | .......... |
| Union | 137,684 | 1,425 | 97,269 | .......... | 16 | 6 | 4 | 5 | 1 | .......... | .......... | .......... |
| Undistributed gold | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... |

| COUNTIES. | EMPLOYÉS ABOVE GROUND. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | |
| | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. |
| Total | 59 | 132 | 1,490 | 3 | $3.32 | $2.92 | $2.29 | $0.83 | 140 | 199 | 130 | 240 |
| Baker | 7 | 23 | 227 | .......... | 4.63 | 4.40 | 2.31 | .......... | 156 | 136 | 147 | .......... |
| Columbia | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... |
| Coos | 14 | .......... | 95 | .......... | 2.75 | .......... | 2.58 | .......... | 105 | .......... | 106 | .......... |
| Crook | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... |
| Curry | 9 | 12 | 21 | .......... | 3.50 | 3.69 | 3.50 | .......... | 48 | 21 | 32 | .......... |
| Douglas | 11 | 66 | 66 | .......... | 3.00 | 2.00 | 2.00 | .......... | 200 | 200 | 54 | .......... |
| Grant | 4 | 7 | 175 | 1 | 4.25 | 3.67 | 2.46 | 1.00 | 173 | 240 | 152 | 360 |
| Jackson | 3 | 2 | 90 | 2 | 2.67 | 2.50 | 1.81 | 0.75 | 190 | 190 | 114 | 180 |
| Josephine | 5 | .......... | 114 | .......... | 3.00 | .......... | 2.09 | .......... | 185 | .......... | 137 | .......... |
| Lane | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... |
| Linn | 1 | .......... | 4 | .......... | 2.50 | .......... | 2.00 | .......... | 300 | .......... | 150 | .......... |
| Malheur | .......... | .......... | 42 | .......... | .......... | .......... | 2.00 | .......... | .......... | .......... | 108 | .......... |
| Union | 5 | 22 | 38 | .......... | 3.63 | 3.50 | 2.64 | .......... | 118 | 344 | 210 | .......... |
| Undistributed gold | .......... | .......... | 618 | .......... | .......... | .......... | 2.29 | .......... | .......... | .......... | 130 | .......... |

| COUNTIES. | EMPLOYÉS BELOW GROUND. | | | | | | | | | | | | Total number of mines. | Number of producing mines. | Mines working but not producing. | Number of mines idle. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | | | | | |
| | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | | | | |
| Total | 22 | 653 | 57 | 1 | $3.92 | $3.16 | $2.23 | $1.50 | 194 | 157 | 200 | 40 | 285 | 200 | 30 | 55 |
| Baker | 3 | 313 | 34 | .......... | 4.50 | 3.46 | 2.03 | .......... | 230 | 160 | 150 | .......... | 47 | 34 | 6 | 7 |
| Columbia | .......... | 2 | .......... | .......... | .......... | 3.00 | .......... | .......... | .......... | 20 | .......... | .......... | 2 | .......... | 1 | 1 |
| Coos | 7 | 87 | .......... | .......... | 3.00 | 2.96 | .......... | .......... | 60 | 91 | .......... | .......... | 28 | 25 | 3 | .......... |
| Crook | .......... | 2 | .......... | .......... | .......... | 3.00 | .......... | .......... | .......... | 60 | .......... | .......... | 1 | 1 | .......... | .......... |
| Curry | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | 12 | 6 | 1 | 5 |
| Douglas | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | 13 | 5 | 1 | 7 |
| Grant | 2 | 109 | 10 | .......... | 4.25 | 2.55 | 2.38 | .......... | 332 | 125 | 230 | .......... | 42 | 31 | 6 | 5 |
| Jackson | .......... | 14 | .......... | 1 | .......... | 2.31 | .......... | 1.50 | .......... | 188 | .......... | 40 | 42 | 24 | 6 | 12 |
| Josephine | .......... | 1 | .......... | .......... | .......... | 2.00 | .......... | .......... | .......... | 163 | .......... | .......... | 48 | 36 | 2 | 10 |
| Lane | 1 | 3 | .......... | .......... | 5.00 | 4.00 | .......... | .......... | 30 | 30 | .......... | .......... | 2 | .......... | 1 | 1 |
| Linn | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | 1 | .......... | 1 | .......... |
| Malheur | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | 23 | 22 | .......... | 1 |
| Union | 9 | 122 | 13 | .......... | 4.25 | 3.19 | 2.64 | .......... | 273 | 228 | 309 | .......... | 24 | 16 | 2 | 6 |
| Undistributed gold | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### OREGON—Continued.

| COUNTIES. | EXPENDITURES. | | | | | | | | | | VALUE OF MINING PROPERTY. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grand total of expenditures. | Grand total of wagos. | Total wages paid in 1889. | Paid to contractors. | Office force. | | | | Value of supplies. | Other expenditures. | Total value of plant. | Value of buildings. | Value of railroads on surface. | Machinery. | Underground improvements. |
| | | | | | Males. | | Females. | | | | | | | | |
| | | | | | Number. | Wages paid. | Number. | Wages paid. | | | | | | | |
| Total | $1, 604, 781 | $970, 758 | $909, 001 | $13, 907 | 28 | $47, 850 | | | $549, 745 | $84, 278 | $15, 151, 203 | $684, 004 | $28, 626 | $486, 403 | $1,524,368 |
| Baker | 395, 211 | 296, 760 | 268, 882 | 6, 726 | 9 | 21, 152 | | | 86, 817 | 11, 634 | 5, 241, 536 | 60, 269 | 21, 240 | 117, 988 | 477, 723 |
| Columbia | 120 | 120 | 120 | | | | | | | | 5, 000 | | | | 100 |
| Coos | 69. 678 | 54, 458 | 54, 458 | | | | | | 15, 074 | 146 | 665, 760 | 4, 015 | | 15, 330 | 15, 330 |
| Crook | 375 | 360 | 360 | | | | | | 15 | | | | | | |
| Curry | 6, 591 | 4, 365 | 4, 365 | | | | | | 2, 100 | 126 | 57, 780 | 2, 310 | | 1, 080 | 9, 750 |
| Douglas | 365, 456 | 57, 071 | 43, 791 | | 11 | 13, 280 | | | 275, 385 | 33, 000 | 6, 002, 150 | 552, 200 | 5, 500 | 225, 500 | 550, 000 |
| Grant | 177, 634 | 107, 665 | 103, 152 | 698 | 2 | 3, 815 | | | 47, 763 | 22, 206 | 915, 785 | 4, 082 | 1, 275 | 38, 112 | 171, 620 |
| Jackson | 48, 785 | 32, 080 | 30, 182 | | 1 | 1, 898 | | | 15, 948 | 757 | 257, 324 | 6, 006 | 338 | 29, 122 | 19, 781 |
| Josephine | 59, 128 | 36, 265 | 36, 265 | | | | | | 15, 126 | 7, 737 | 579, 673 | 11, 766 | 273 | 33, 496 | 95, 593 |
| Lane | 910 | 710 | 510 | 200 | | | | | 200 | | 1, 525 | 100 | | 75 | 1, 000 |
| Linn | 2, 500 | 2, 000 | 2, 000 | | | | | | 500 | | | | | | |
| Malheur | 14, 823 | 10, 150 | 9, 100 | 1, 050 | | | | | 4, 323 | 850 | 123, 200 | 7, 175 | | 4, 025 | |
| Union | 263, 570 | 168, 754 | 155, 816 | 5, 233 | 5 | 7, 705 | | | 86, 494 | 8, 322 | 1, 301, 470 | 36, 081 | | 21, 675 | 183, 471 |
| Undistributed gold | 200, 000 | 200, 000 | 200, 000 | | | | | | | | | | | | |

| COUNTIES. | VALUE OF MINING PROPERTY—continued. | | | VALUE OF MILL OR REDUCTION WORKS. | | | | MOTIVE POWER. | | | | | | | Number of animals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mine supplies. | Mine proper. | Cash. | Total. | Buildings. | Machinery. | Supplies. | Boilers. | | Engines. | | Other power. | Motors. | | |
| | | | | | | | | Number. | Horse power. | Number. | Horse power. | | Number. | Horse power. | |
| Total | $93, 116 | $12, 198, 130 | $136, 556 | $1,145,006 | $447, 993 | $650, 188 | $46, 825 | 26 | 811 | 16 | 1, 796 | | 34 | 339 | 126 |
| Baker | 19, 797 | 4, 542, 572 | 1, 947 | 378, 555 | 216, 913 | 144, 650 | 16, 992 | 9 | 372 | 3 | 297 | | 12 | 133 | 58 |
| Columbia | 5 | 4, 895 | | | | | | | | | | | | | |
| Coos | 11, 242 | 594, 293 | 25, 550 | | | | | | | | | | | | |
| Crook | | | | | | | | | | | | | | | |
| Curry | 1, 020 | 43, 620 | | | | | | | | | | | | | |
| Douglas | 24, 200 | 4, 556, 750 | 88, 000 | 572, 000 | 176, 000 | 374, 000 | 22, 000 | | | | | Water, 11 | 11 | 110 | 22 |
| Grant | 4, 453 | 696, 243 | | 78, 589 | 12, 154 | 64, 800 | 1, 635 | 7 | 213 | 5 | 245 | | 7 | 70 | 7 |
| Jackson | 13, 166 | 186, 727 | 2. 184 | | | | | 1 | 10 | 1 | 88 | Various, 10 | | | 2 |
| Josephine | 8, 780 | 416, 140 | 13, 625 | 5, 232 | 1, 526 | 3, 488 | 218 | 1 | 11 | 1 | 17 | Various, 18 | | | 14 |
| Lane | 100 | 250 | | | | | | | | | | | | | |
| Linn | | | | | | | | | | | | | | | |
| Malheur | 175 | 106, 575 | 5, 250 | | | | | 3 | 21 | 3 | 56 | | 3 | 21 | |
| Union | 10, 178 | 1, 050, 065 | | 110, 630 | 41, 400 | 63, 250 | 5, 980 | 5 | 184 | 3 | 1, 093 | Water, 1 | 1 | 5 | 23 |
| Undistributed gold | | | | | | | | | | | | | | | |

### SOUTH DAKOTA.

| COUNTIES. | Total amount of ore produced. (Short tons.) | Total amount of ore sold. (Short tons.) | Total amount of ore treated. (Short tons.) | ASSAY VALUE OF ORE SOLD. | | TOTAL BULLION VALUE. | | | ESTIMATED COINING VALUE OF BULLION PRODUCED FROM ORE SOLD. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gold. | Silver. | Grand total bullion. | Gold. | Silver. | Gold. | Silver. |
| Total | 963, 820 | 3, 902 | 936, 421 | $69, 668 | $116, 793 | $3, 226, 468 | $3, 091, 137 | $135, 331 | $66, 184 | $110, 954 |
| Custer | | | | | | 3, 500 | 3, 500 | | | |
| Lawrence | 962, 139 | 3, 902 | 934, 740 | 69, 668 | 116, 793 | 2, 991, 889 | 2, 856, 558 | 135, 331 | 66, 184 | 110, 954 |
| Pennington | 1, 681 | | 1, 681 | | | 31, 079 | 31, 079 | | | |
| Undistributed gold | | | | | | 200, 000 | 200, 000 | | | |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### SOUTH DAKOTA—Continued.

| COUNTIES. | COINING VALUE OF BULLION PRODUCED FROM ORE TREATED. | | PLACER BULLION. | | Total producing mines reported. | NUMBER OF MINES PRODUCING— | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gold. | Silver. | Gold. | Silver. | | Less than $1,000. | $1,000 to $10,000. | $10,000 to $50,000. | $50,000 to $100,000. | $100,000 to $250,000. | $250,000 to $500,000. | Over $500,000. |
| Total | $2,795,453 | $24,377 | $29.500 | | 31 | 12 | 6 | 6 | 3 | | 1 | 3 |
| Custer | | | 3,500 | | 2 | 2 | | | | | | |
| Lawrence | 2,790,374 | 24,377 | | | 22 | 4 | 5 | 6 | 3 | | 1 | 3 |
| Pennington | 5,079 | | 26,000 | | 7 | 6 | 1 | | | | | |
| Undistributed gold | | | | | | | | | | | | |

| COUNTIES. | EMPLOYÉS ABOVE GROUND. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | |
| | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. |
| Total | 31 | 260 | 554 | | $4.57 | $3.23 | $2.85 | | 272 | 311 | 204 | |
| Custer | | | 10 | | | | 2.84 | | | | 123 | |
| Lawrence | 29 | 253 | 107 | | 4.61 | 3.22 | 2.84 | | 282 | 318 | 302 | |
| Pennington | 2 | 7 | 94 | | 4.00 | 3.50 | 2.86 | | 126 | 49 | 102 | |
| Undistributed gold | | | 343 | | | | 2.85 | | | | 204 | |

| COUNTIES. | EMPLOYÉS BELOW GROUND. | | | | | | | | | | | | Total number of mines. | Number of producing mines. | Mines working but not producing. | Number of mines idle. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | | | | | |
| | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | | | | |
| Total | 31 | 645 | 369 | | $4.75 | $3.49 | $2.99 | | 299 | 293 | 321 | | 48 | 31 | 8 | 9 |
| Custer | | | | | | | | | | | | | 2 | 2 | | |
| Lawrence | 30 | 637 | 367 | | 4.78 | 3.50 | 2.99 | | 306 | 296 | 322 | | 36 | 22 | 6 | 8 |
| Pennington | 1 | 8 | 2 | | 4.00 | 3.00 | 2.50 | | 90 | 90 | 90 | | 10 | 7 | 2 | 1 |
| Undistributed gold | | | | | | | | | | | | | | | | |

| COUNTIES. | EXPENDITURES. | | | | | | | | | | VALUE OF MINING PROPERTY. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grand total of expenditures. | Grand total of wages. | Total wages paid in 1889. | Paid to contractors. | Office force. | | | | Value of supplies. | Other expenditures. | Total value of plant. | Value of buildings. | Value of railroads on surface. | Machinery. | Underground improvements. |
| | | | | | Males. | | Females. | | | | | | | | |
| | | | | | No. | Wages paid. | No. | Wages paid. | | | | | | | |
| Total | $2,589,383 | $1,742,042 | $1,605,738 | $120,169 | 9 | $16,135 | | | $721,139 | $126,202 | $5,271,110 | $124,775 | $8,087 | $336,923 | $603,888 |
| Custer | 3,500 | 3,500 | 3,500 | | | | | | | | | | | | |
| Lawrence | 2,345,505 | 1,503,875 | 1,369,371 | 120,169 | 8 | 14,335 | | | 719,929 | 121,701 | 5,082,535 | 120,775 | 8,037 | 312,468 | 598,818 |
| Pennington | 40,378 | 34,667 | 32,867 | | 1 | 1,800 | | | 1,210 | 4,501 | 188,575 | 4,000 | 50 | 24,455 | 5,070 |
| Undistributed gold | 200,000 | 200,000 | 200,000 | | | | | | | | | | | | |

| COUNTIES. | VALUE OF MINING PROPERTY—continued. | | | VALUE OF MILL OR REDUCTION WORKS. | | | | MOTIVE POWER. | | | | | | | Number of animals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mine supplies. | Mine proper. | Cash. | Total. | Buildings. | Machinery. | Supplies. | Boilers. | | Engines. | | Other power. | Motors. | | |
| | | | | | | | | Number. | Horse power. | Number. | Horse power. | | Number. | Horse power. | |
| Total | $37,462 | $4,140,827 | $19,148 | $573.774 | $155,402 | $389,068 | $29,304 | 66 | 3,427 | 41 | 2,969 | | | | 71 |
| Custer | | | | | | | | | | | | | | | |
| Lawrence | 37,462 | 3,985,827 | 19,148 | 560,274 | 154,902 | 376,068 | 29,304 | 61 | 3,287 | 40 | 2,936 | Water, 1 | | | 69 |
| Pennington | | 155,000 | | 13,500 | 500 | 13,000 | | 5 | 140 | 1 | 33 | | | | 2 |
| Undistributed gold | | | | | | | | | | | | | | | |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### TEXAS.

| COUNTIES. | Total amount of ore produced. (Short tons.) | Total amount of ore sold. (Short tons.) | Total amount of ore treated. (Short tons.) | ASSAY VALUE OF ORE SOLD. Gold. | ASSAY VALUE OF ORE SOLD. Silver. | TOTAL BULLION VALUE. Grand total bullion. | TOTAL BULLION VALUE. Gold. | TOTAL BULLION VALUE. Silver. | ESTIMATED COINING VALUE OF BULLION PRODUCED FROM ORE SOLD. Gold. | ESTIMATED COINING VALUE OF BULLION PRODUCED FROM ORE SOLD. Silver. |
|---|---|---|---|---|---|---|---|---|---|---|
| Total | 12, 996 | 1, 355 | 10, 441 | $7, 188 | $86, 968 | $425, 001 | $6, 828 | $418, 173 | $6, 828 | $82, 620 |
| El Paso | 2, 355 | 1, 355 | ........ | 7, 188 | 86, 968 | 89, 448 | 6, 828 | 82, 620 | 6, 828 | 82, 620 |
| Presidio | 10, 641 | ........ | 10, 441 | ........ | ........ | 335, 553 | ........ | 335, 553 | ........ | ........ |

| COUNTIES. | COINING VALUE OF BULLION PRODUCED FROM ORE TREATED. Gold. | COINING VALUE OF BULLION PRODUCED FROM ORE TREATED. Silver. | PLACER BULLION. Gold. | PLACER BULLION. Silver. | Total producing mines reported. | NUMBER OF MINES PRODUCING— Less than $1,000. | $1,000 to $10,000. | $10,000 to $50,000. | $50,000 to $100,000. | $100,000 to $250,000. | $250,000 to $500,000. | Over $500,000. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | ........ | $335, 553 | ........ | ........ | 5 | 2 | ........ | ........ | 1 | 2 | ........ | ........ |
| El Paso | ........ | ........ | ........ | ........ | 2 | 1 | ........ | ........ | 1 | ........ | ........ | ........ |
| Presidio | ........ | 335, 553 | ........ | ........ | 3 | 1 | ........ | ........ | ........ | 2 | ........ | ........ |

| COUNTIES. | EMPLOYÉS ABOVE GROUND. Average number employed. Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Average wages per day. Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Average number of days worked during year. Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 7 | 10 | 36 | ........ | $4. 62 | $2. 83 | $2. 07 | ........ | 130 | 174 | 147 | ........ |
| El Paso | 1 | 5 | 4 | ........ | 3. 00 | 1. 85 | 2. 50 | ........ | 100 | 193 | 100 | ........ |
| Presidio | 6 | 5 | 32 | ........ | 4. 89 | 3. 80 | 2. 02 | ........ | 135 | 154 | 153 | ........ |

| COUNTIES. | EMPLOYÉS BELOW GROUND. Average number employed. Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Average wages per day. Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Average number of days worked during year. Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Total number of mines. | Number of producing mines. | Mines working but not producing. | Number of mines idle. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 5 | 78 | 192 | ........ | $2. 60 | $1. 27 | $1. 25 | ........ | 163 | 175 | 156 | ........ | 10 | 5 | 1 | 4 |
| El Paso | 4 | 60 | 6 | ........ | 2. 50 | 1. 25 | 1. 10 | ........ | 193 | 193 | 193 | ........ | 5 | 2 | ........ | 3 |
| Presidio | 1 | 18 | 186 | ........ | 3. 00 | 1. 33 | 1. 25 | ........ | 41 | 114 | 155 | ........ | 5 | 3 | 1 | 1 |

| COUNTIES. | EXPENDITURES. Grand total of expenditures. | Grand total of wages. | Total wages paid in 1889. | Paid to contractors. | Office force. Males. Number. | Males. Wages paid. | Females. Number. | Females. Wages paid. | Value of supplies. | Other expenditures. | VALUE OF MINING PROPERTY. Total value of plant. | Value of buildings. | Value of railroads on surface. | Machinery. | Underground improvements. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | $205, 808 | $82, 586 | $76, 146 | $270 | 5 | $6, 170 | ........ | ........ | $17, 602 | $105, 620 | $405, 292 | $7, 900 | ........ | $9, 200 | $25, 000 |
| El Paso | 23, 355 | 21, 621 | 20, 731 | 270 | 2 | 620 | ........ | ........ | 1, 634 | 100 | 200, 000 | 3, 200 | ........ | 3, 200 | 15, 000 |
| Presidio | 182, 453 | 60, 965 | 55, 415 | ........ | 3 | 5, 550 | ........ | ........ | 15, 968 | 105, 520 | 205, 292 | 4, 700 | ........ | 6, 000 | 10, 000 |

| COUNTIES. | VALUE OF MINING PROPERTY—continued. Mine supplies. | Mine proper. | Cash. | VALUE OF MILL OR REDUCTION WORKS. Total. | Buildings. | Machinery. | Supplies. | MOTIVE POWER. Boilers. Number. | Boilers. Horse power. | Engines. Number. | Engines. Horse power. | Other power. | Motors. Number. | Motors. Horse power. | Number of animals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | $4, 192 | $357, 000 | $2, 000 | $49, 560 | $10, 000 | $20, 000 | $19, 560 | 2 | 20 | 2 | 60 | ........ | 6 | ........ | 31 |
| El Paso | 600 | 178, 000 | ........ | ........ | ........ | ........ | ........ | 2 | 20 | 2 | 60 | ........ | ........ | ........ | 20 |
| Presidio | 3, 592 | 179, 000 | 2, 000 | 49, 560 | 10, 000 | 20, 000 | 19, 560 | ........ | ........ | ........ | ........ | Windlass, 1 | 6 | ........ | 11 |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### UTAH.

| COUNTIES. | Total amount of ore produced. (Short tons.) | Total amount of ore sold. (Short tons.) | Total amount of ore treated. (Short tons.) | ASSAY VALUE OF ORE SOLD. | | TOTAL BULLION VALUE. | | | ESTIMATED COINING VALUE OF BULLION PRODUCED FROM ORE SOLD. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gold. | Silver. | Grand total bullion. | Gold. | Silver. | Gold. | Silver. |
| Total | 214, 548 | 125, 051 | 64, 818 | $406, 312 | $6, 373, 380 | $9, 544, 680 | $487, 666 | $9, 057, 014 | $387, 390 | $6, 809, 871 |
| Beaver | 12, 942 | 12, 771 | 114 | 54 | 380, 950 | 363, 322 | 327 | 362, 995 | 51 | 361, 902 |
| Boxelder | | | | | | | | | | |
| Juab | 52, 251 | 52, 183 | | 224, 333 | 3, 051, 903 | 3, 112, 422 | 213, 115 | 2, 899, 307 | 213, 115 | 2, 899, 307 |
| Piute | 174 | | | | | 8, 995 | 1, 395 | 7, 600 | 1, 395 | 7, 600 |
| Salt Lake | 49, 836 | 35, 482 | | 77, 776 | 645, 648 | 687, 263 | 73, 887 | 613, 376 | 73, 887 | 613, 376 |
| Summit | 82, 537 | 20, 647 | 58, 323 | 92, 941 | 2, 213, 081 | 5, 029, 083 | 88, 294 | 4, 940, 789 | 88, 294 | 2, 850, 964 |
| Tooele | 12, 595 | 3, 948 | 2, 268 | 11, 208 | 79, 693 | 124, 157 | 10, 648 | 113, 509 | 10, 648 | 74, 722 |
| Wasatch | 100 | 20 | | | 2, 105 | 2, 000 | | 2, 000 | | 2, 000 |
| Washington | 4, 113 | | 4, 113 | | | 117, 438 | | 117, 438 | | |
| Undistributed gold | | | | | | 100, 000 | 100, 000 | | | |

| COUNTIES. | COINING VALUE OF BULLION PRODUCED FROM ORE TREATED. | | PLACER BULLION. | | Total producing mines reported. | NUMBER OF MINES PRODUCING— | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gold. | Silver. | Gold. | Silver. | | Less than $1,000. | $1,000 to $10,000. | $10,000 to $50,000. | $50,000 to $100,000. | $100,000 to $250,000. | $250,000 to $500,000. | Over $500,000. |
| Total | $276 | $2, 247, 143 | | | 66 | 9 | 21 | 19 | 3 | 7 | 3 | 4 |
| Beaver | 276 | 1, 093 | | | 4 | 3 | | | | | 1 | |
| Boxelder | | | | | | | | | | | | |
| Juab | | | | | 16 | | 5 | 4 | 2 | 2 | 1 | 2 |
| Piute | | | | | 2 | 1 | 1 | | | | | |
| Salt Lake | | | | | 22 | 1 | 9 | 9 | 1 | 2 | | |
| Summit | | 2, 089, 825 | | | 9 | | 2 | 2 | | 2 | 1 | 2 |
| Tooele | | 38, 787 | | | 10 | 3 | 3 | 4 | | | | |
| Wasatch | | | | | 1 | | 1 | | | | | |
| Washington | | 117, 438 | | | 2 | 1 | | | | 1 | | |
| Undistributed gold | | | | | | | | | | | | |

| COUNTIES. | EMPLOYÉS ABOVE GROUND. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | |
| | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. |
| Total | 85 | 171 | 475 | 2 | $5. 27 | $3. 93 | $3. 14 | $1. 00 | 307 | 319 | 311 | 365 |
| Beaver | | 6 | 5 | | | 3. 50 | 2. 60 | | | 341 | 176 | |
| Boxelder | | | | | | | | | | | | |
| Juab | 54 | 81 | 41 | | 5. 39 | 4. 00 | 3. 00 | | 310 | 327 | 270 | |
| Piute | | | 1 | | | | 3. 00 | | | | 80 | |
| Salt Lake | 10 | 22 | 43 | 2 | 5. 14 | 3. 63 | 2. 85 | 1. 00 | 321 | 296 | 279 | 365 |
| Summit | 15 | 40 | 189 | | 5. 25 | 4. 14 | 3. 31 | | 316 | 353 | 354 | |
| Tooele | 2 | 11 | 16 | | 4. 00 | 3. 65 | 3. 00 | | 218 | 270 | 302 | |
| Wasatch | 2 | 5 | 13 | | 4. 25 | 4. 20 | 2. 50 | | 225 | 210 | 185 | |
| Washington | 2 | 6 | 12 | | 5. 00 | 3. 50 | 3. 00 | | 240 | 240 | 105 | |
| Undistributed gold | | | 155 | | | | 3. 14 | | | | 311 | |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### UTAH—Continued.

| COUNTIES. | EMPLOYÉS BELOW GROUND. | | | | | | | | | | | | Total number of mines. | Number of producing mines. | Mines working but not producing. | Number of mines idle. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | | | | | |
| | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | | | | |
| Total | 132 | 2,065 | 274 | 1 | $4.21 | $3.04 | $2.80 | $1.50 | 279 | 273 | 316 | 200 | 129 | 66 | 26 | 37 |
| Beaver | 2 | 55 | 13 | | 4.00 | 2.96 | 2.50 | | 341 | 300 | 341 | | 6 | 4 | 1 | 1 |
| Boxelder | | 2 | | | | 3.00 | | | | 83 | | | 1 | | 1 | |
| Juab | 82 | 979 | 81 | | 4.00 | 3.02 | 3.00 | | 263 | 226 | 293 | | 29 | 16 | 7 | 6 |
| Piute | | 5 | | | | 3.00 | | | | 80 | | | 8 | 2 | | 6 |
| Salt Lake | 15 | 284 | 60 | | 4.50 | 3.06 | 2.80 | | 311 | 292 | 334 | | 38 | 22 | 5 | 11 |
| Summit | 21 | 613 | 75 | | 4.77 | 3.04 | 2.88 | | 324 | 346 | 354 | | 22 | 9 | 8 | 5 |
| Tooele | 6 | 76 | 24 | 1 | 4.58 | 3.06 | 2.69 | 1.50 | 293 | 260 | 315 | 200 | 18 | 10 | 2 | 6 |
| Wasatch | 4 | 21 | 1 | | 4.00 | 3.50 | 2.50 | | 225 | 212 | 300 | | 3 | 1 | 2 | |
| Washington | 2 | 30 | 20 | | 4.50 | 3.00 | 2.00 | | 240 | 240 | 200 | | 4 | 2 | | 2 |
| Undistributed gold | | | | | | | | | | | | | | | | |

| COUNTIES. | EXPENDITURES. | | | | | | | | | | VALUE OF MINING PROPERTY. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grand total of expenditures. | Grand total of wages. | Total wages paid in 1889. | Paid to contractors. | Office force. | | | | Value of supplies. | Other expenditures. | Total value of plant. | Value of buildings. | Value of railroads on surface. | Machinery. | Underground improvements. |
| | | | | | Males. | | Females. | | | | | | | | |
| | | | | | No. | Wages paid. | No. | Wages paid. | | | | | | | |
| Total | $4,875,211 | $3,022,648 | $2,869,852 | $105,535 | 33 | $47,261 | | | $1,111,963 | $740,600 | $63,009,466 | $1,229,109 | $138,378 | $1,013,509 | $22,111,817 |
| Beaver | 1,554 | 1,069 | 1,069 | | | | | | 170 | 315 | 2,258,526 | 37,170 | 5,250 | 34,335 | 77,158 |
| Boxelder | 750 | 750 | 500 | | 1 | 250 | | | | | 57,800 | 500 | | 1,000 | 6,000 |
| Juab | 1,899,253 | 1,087,238 | 1,087,238 | | | | | | 349,248 | 462,767 | 26,339,052 | 164,084 | 8,160 | 366,588 | 5,042,404 |
| Piute | 3,216 | 2,157 | 2,025 | 92 | | 40 | | | 794 | 265 | 583,895 | 6,452 | 112 | 577 | 86,148 |
| Salt Lake | 542,647 | 428,916 | 396,163 | 24,539 | 6 | 8,214 | | | 88,351 | 25,380 | 4,771,818 | 25,251 | 55,148 | 84,360 | 1,818,049 |
| Summit | 2,018,827 | 1,168,795 | 1,087,439 | 49,055 | 21 | 32,301 | | | 602,420 | 247,612 | 26,629,744 | 966,901 | 62,472 | 461,821 | 14,546,598 |
| Tooele | 200,250 | 152,779 | 115,222 | 31,401 | 4 | 6,156 | | | 43,710 | 3,761 | 1,538,136 | 19,926 | 7,236 | 58,158 | 350,460 |
| Wasatch | 35,625 | 35,625 | 35,625 | | | | | | | | 738,000 | 8,000 | | | 180,000 |
| Washington | 73,089 | 45,319 | 44,571 | 448 | 1 | 300 | | | 27,270 | 500 | 92,495 | 825 | | 6,670 | 5,000 |
| Undistributed gold | 100,000 | 100,000 | 100,000 | | | | | | | | | | | | |

| COUNTIES. | VALUE OF MINING PROPERTY—continued. | | | VALUE OF MILL OR REDUCTION WORKS. | | | | MOTIVE POWER. | | | | | | | Number of animals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mine supplies. | Mine proper. | Cash. | Total. | Buildings. | Machinery. | Supplies. | Boilers. | | Engines. | | Other power. | Motors. | | |
| | | | | | | | | Number. | Horse power. | Number. | Horse power. | | Number. | Horse power. | |
| Total | $605,271 | $35,726,352 | $2,185,030 | $1,445,047 | $408,752 | $857,228 | $179,067 | 139 | 4,525 | 24 | 2,829 | | 13 | 419 | 165 |
| Beaver | 630 | 2,095,170 | 8,813 | 840 | 420 | 315 | 105 | 3 | 136 | | | | | | 3 |
| Boxelder | 300 | 50,000 | | | | | | | | | | | | | |
| Juab | 99,892 | 19,880,684 | 777,240 | | | | | 68 | 3,196 | | 240 | Whims, 27 | | | 54 |
| Piute | 480 | 488,903 | 1,223 | 1,217 | 342 | 726 | 149 | | 3 | | 3 | | | | |
| Salt Lake | 43,320 | 2,699,520 | 46,170 | 234,367 | 42,180 | 186,618 | 5,569 | 17 | 545 | 7 | 254 | | 8 | 294 | 51 |
| Summit | 150,173 | 9,090,195 | 1,351,584 | 1,105,623 | 346,540 | 590,259 | 168,824 | 35 | | | 1,823 | | 5 | 125 | 35 |
| Tooele | 10,476 | 1,091,880 | | 86,400 | 15,120 | 66,960 | 4,320 | 14 | 585 | 15 | 409 | | | | 23 |
| Wasatch | 300,000 | 250,000 | | | | | | | | | | | | | |
| Washington | | 80,000 | | 16,600 | 4,150 | 12,350 | 100 | 2 | 60 | 2 | 100 | | | | |
| Undistributed gold | | | | | | | | | | | | | | | |

## GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### WASHINGTON.

| COUNTIES. | Total amount of ore produced. (Short tons.) | Total amount of ore sold. (Short tons.) | Total amount of ore treated. (Short tons.) | ASSAY VALUE OF ORE SOLD. | | TOTAL BULLION VALUE. | | | ESTIMATED COINING VALUE OF BULLION PRODUCED FROM ORE SOLD. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gold. | Silver. | Grand total bullion. | Gold. | Silver. | Gold. | Silver. |
| Total | 3, 626 | 83 | 361 | $20, 341 | $38, 354 | $222, 951 | $186, 150 | $36, 801 | $19, 324 | $36, 937 |
| Asotin | | | | | | 1, 500 | 1, 500 | | | |
| Kittitas | 370 | | 350 | | | 10, 822 | 10, 822 | | | |
| Okanogan | 2, 101 | 14 | 9 | 5, 007 | 15, 827 | 20, 157 | 4, 757 | 15, 400 | 4, 757 | 15, 536 |
| Snohomish | | | | 316 | 204 | 494 | 300 | 194 | 300 | 194 |
| Stevens | 1, 155 | 69 | 2 | 15, 018 | 22, 323 | 35, 478 | 14, 271 | 21, 207 | 14, 267 | 21, 207 |
| Wallawalla | | | | | | 2, 500 | 2, 500 | | | |
| Whitman | | | | | | 2, 000 | 2, 000 | | | |
| Undistributed gold, placer mines. | | | | | | 150, 000 | 150, 000 | | | |

| COUNTIES. | COINING VALUE OF BULLION PRODUCED FROM ORE TREATED. | | PLACER BULLION. | | Total producing mines reported. | NUMBER OF MINES PRODUCING— | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gold. | Silver. | Gold. | Silver. | | Less than $1, 000. | $1, 000 to $10, 000. | $10, 000 to $50, 000. | $50, 000 to $100, 000. | $100, 000 to $250, 000. | $250, 000 to $500, 000. | Over $500, 000. |
| Total | $4, 504 | $364 | $162, 322 | | 70 | 65 | 4 | 1 | | | | |
| Asotin | | | 1, 500 | | 5 | 5 | | | | | | |
| Kittitas | 4, 500 | | 6, 322 | | 13 | 11 | 2 | | | | | |
| Okanogan | | 364 | | | 13 | 11 | 2 | | | | | |
| Snohomish | | | | | 1 | 1 | | | | | | |
| Stevens | 4 | | | | 23 | 22 | | 1 | | | | |
| Wallawalla | | | 2, 500 | | 8 | 8 | | | | | | |
| Whitman | | | 2, 000 | | 7 | 7 | | | | | | |
| Undistributed gold, placer mines. | | | 150, 000 | | | | | | | | | |

| COUNTIES. | EMPLOYÉS ABOVE GROUND. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | |
| | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. |
| Total | 3 | 3 | 394 | | $5. 00 | $4. 00 | $3. 00 | | 221 | 280 | 139 | |
| Asotin | | | 4 | | | | 3. 00 | | | | 125 | |
| Kittitas | | | 24 | | | | 2. 69 | | | | 111 | |
| Okanogan | 2 | 3 | 19 | | 5. 00 | 4. 00 | 3. 34 | | 211 | 280 | 164 | |
| Snohomish | | | | | | | | | | | | |
| Stevens | 1 | | 3 | | 5. 00 | | 3. 00 | | 240 | | 240 | |
| Wallawalla | | | 6 | | | | 3. 00 | | | | 139 | |
| Whitman | | | 5 | | | | 3. 00 | | | | 133 | |
| Undistributed gold, placer mines. | | | 333 | | | | 3. 00 | | | | 139 | |

GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

WASHINGTON—Continued.

| COUNTIES. | EMPLOYÉS BELOW GROUND. | | | | | | | | | | | | Total number of mines. | Number of producing mines. | Mines working but not producing. | Number of mines idle. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | | | | | |
| | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | | | | |
| Total | 8 | 187 | 7 | | $4.69 | $3.43 | $3.28 | | 124 | 134 | 154 | | 86 | 70 | 7 | 9 |
| Asotin | | | | | | | | | | | | | 5 | 5 | | |
| Kittitas | 1 | 2 | 1 | | 3.00 | 2.50 | 3.00 | | 135 | 135 | 135 | | 19 | 13 | 1 | 5 |
| Okanogan | 2 | 87 | 6 | | 6.00 | 3.55 | 3.33 | | 210 | 154 | 157 | | 15 | 13 | 1 | 1 |
| Snohomish | 1 | 2 | | | 4.50 | 2.00 | | | 30 | 30 | | | 3 | 1 | 1 | 1 |
| Stevens | 4 | 96 | | | 4.50 | 3.37 | | | 102 | 118 | | | 29 | 23 | 4 | 2 |
| Wallawalla | | | | | | | | | | | | | 8 | 8 | | |
| Whitman | | | | | | | | | | | | | 7 | 7 | | |
| Undistributed gold, placer mines. | | | | | | | | | | | | | | | | |

| COUNTIES. | EXPENDITURES. | | | | | | | | | | VALUE OF MINING PROPERTY. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grand total of expenditures. | Grand total of wages. | Total wages paid in 1889. | Paid to contractors. | Office force. | | | | Value of supplies. | Other expenditures. | Total value of plant. | Value of buildings. | Value of railroads on surface. | Machinery. | Underground improvements. |
| | | | | | Males. | | Females. | | | | | | | | |
| | | | | | Number. | Wages paid. | Number. | Wages paid. | | | | | | | |
| Total | $328,816 | $282,759 | $277,859 | $2,500 | 1 | $2,400 | | | $35,320 | $10,737 | $3,536,925 | $10,520 | $500 | $14,765 | $399,840 |
| Asotin | 1,500 | 1,500 | 1,500 | | | | | | | | | | | | |
| Kittitas | 11,864 | 5,304 | 5,304 | | | | | | 2,235 | 4,325 | 314,440 | 2,095 | 400 | 4,175 | 50,640 |
| Okanogan | 92,381 | 70,814 | 68,414 | | 1 | 2,400 | | | 21,060 | 507 | 1,558,565 | 4,500 | | 7,185 | 131,500 |
| Snohomish | 6,400 | 3,300 | 3,300 | | | | | | 3,050 | 50 | 74,750 | 500 | | 50 | 8,200 |
| Stevens | 62,171 | 47,341 | 44,841 | 2,500 | | | | | 8,975 | 5,855 | 1,589,170 | 3,425 | 100 | 3,355 | 209,500 |
| Wallawalla | 2,500 | 2,500 | 2,500 | | | | | | | | | | | | |
| Whitman | 2,000 | 2,000 | 2,000 | | | | | | | | | | | | |
| Undistributed gold, placer mines. | 150,000 | 150,000 | 150,000 | | | | | | | | | | | | |

| COUNTIES. | VALUE OF MINING PROPERTY—continued. | | | VALUE OF MILL OR REDUCTION WORKS. | | | | MOTIVE POWER. | | | | | | | Number of animals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mine supplies. | Mine proper. | Cash. | Total. | Buildings. | Machinery. | Supplies. | Boilers. | | Engines. | | Other power. | Motors. | | |
| | | | | | | | | Number. | Horse power. | Number. | Horse power. | | Number. | Horse power. | |
| Total | $6,260 | $3,103,040 | $2,000 | $34,550 | $18,650 | $11,900 | $4,000 | 2 | 30 | 2 | 21 | | 12 | 81 | 19 |
| Asotin | | | | | | | | | | | | | | | |
| Kittitas | 330 | 256,800 | | 5,900 | 2,000 | 3,900 | | | | | | Water | 6 | 81 | 12 |
| Okanogan | 3,580 | 1,409,800 | 2,000 | 28,650 | 16,650 | 8,000 | 4,000 | 2 | 30 | 2 | 21 | Windlasses, 2<br>Whim, 1 | 3 | | 2 |
| Snohomish | | 66,000 | | | | | | | | | | Water | | | |
| Stevens | 2,350 | 1,370,440 | | | | | | | | | | Windlass, 1<br>Whims, 2 | 3 | | 5 |
| Wallawalla | | | | | | | | | | | | | | | |
| Whitman | | | | | | | | | | | | | | | |
| Undistributed gold, placer mines. | | | | | | | | | | | | | | | |

GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

### WYOMING.

| COUNTIES. | Total amount of ore produced. (Short tons.) | Total amount of ore sold. (Short tons.) | Total amount of ore treated. (Short tons.) | ASSAY VALUE OF ORE SOLD. | | TOTAL BULLION VALUE. | | | ESTIMATED COINING VALUE OF BULLION PRODUCED FROM ORE SOLD. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Gold. | Silver. | Grand total bullion. | Gold. | Silver. | Gold. | Silver. |
| Total | 1,336 | ........ | 890 | ........ | ........ | $14,512 | $14,512 | ........ | ........ | ........ |
| Albany | 525 | ........ | 250 | ........ | ........ | 6,172 | 6,172 | ........ | ........ | ........ |
| Carbon | 10 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Crook | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Fremont | 701 | ........ | 640 | ........ | ........ | 8,340 | 8,340 | ........ | ........ | ........ |
| Laramie | 100 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |

| COUNTIES. | COINING VALUE OF BULLION PRODUCED FROM ORE TREATED. | | PLACER BULLION. | | Total producing mines reported. | NUMBER OF MINES PRODUCING— | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gold. | Silver. | Gold. | Silver. | | Less than $1,000. | $1,000 to $10,000. | $10,000 to $50,000. | $50,000 to $100,000. | $100,000 to $250,000. | $250,000 to $500,000. | Over $500,000. |
| Total | $13,340 | ........ | $1,172 | ........ | 11 | 7 | 4 | ........ | ........ | ........ | ........ | ........ |
| Albany | 5,000 | ........ | 1,172 | ........ | 6 | 5 | 1 | ........ | ........ | ........ | ........ | ........ |
| Carbon | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Crook | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Fremont | 8,340 | ........ | ........ | ........ | 5 | 2 | 3 | ........ | ........ | ........ | ........ | ........ |
| Laramie | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |

| COUNTIES. | EMPLOYÉS ABOVE GROUND. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | |
| | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. | Foremen or overseers. | Mechanics. | Laborers. | Boys under 16 years. |
| Total | 14 | 7 | 51 | ........ | $3.86 | $3.07 | $2.36 | ........ | 105 | 56 | 81 | ........ |
| Albany | 10 | 5 | 37 | ........ | 3.80 | 2.70 | 2.38 | ........ | 111 | 62 | 63 | ........ |
| Carbon | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Crook | ........ | ........ | 1 | ........ | ........ | ........ | 3.00 | ........ | ........ | ........ | 35 | ........ |
| Fremont | 4 | 2 | 11 | ........ | 4.00 | 4.00 | 2.32 | ........ | 91 | 40 | 158 | ........ |
| Laramie | ........ | ........ | 2 | ........ | ........ | ........ | 2.00 | ........ | ........ | ........ | 10 | ........ |

| COUNTIES. | EMPLOYÉS BELOW GROUND. | | | | | | | | | | | | Total number of mines. | Number of producing mines. | Mines working but not producing. | Number of mines idle. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked during year. | | | | | | | |
| | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | Foremen or overseers. | Miners. | Laborers. | Boys under 16 years. | | | | |
| Total | 13 | 130 | 11 | ........ | $4.84 | $3.05 | $2.36 | ........ | 80 | 58 | 108 | ........ | 56 | 11 | 41 | 4 |
| Albany | 3 | 57 | 8 | ........ | 4.67 | 2.98 | 2.25 | ........ | 62 | 61 | 82 | ........ | 15 | 6 | 9 | ........ |
| Carbon | ........ | 10 | ........ | ........ | ........ | 3.20 | ........ | ........ | ........ | 68 | ........ | ........ | 4 | ........ | 3 | 1 |
| Crook | ........ | 1 | ........ | ........ | ........ | 3.00 | ........ | ........ | ........ | 40 | ........ | ........ | 3 | ........ | 2 | 1 |
| Fremont | 9 | 39 | 1 | ........ | 4.88 | 3.03 | 4.00 | ........ | 68 | 33 | 50 | ........ | 21 | 5 | 15 | 1 |
| Laramie | 1 | 23 | 2 | ........ | 5.00 | 3.17 | 2.00 | ........ | 240 | 87 | 240 | ........ | 13 | ........ | 12 | 1 |

GOLD AND SILVER STATISTICS OF THE WESTERN STATES AND TERRITORIES—Continued.

WYOMING—Continued.

| COUNTIES. | EXPENDITURES. | | | | | | | | | | VALUE OF MINING PROPERTY. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grand total of expenditures. | Grand total of wages. | Total wages paid in 1889. | Paid to contractors. | Office force. | | | | Value of supplies. | Other expenditures. | Total value of plant. | Value of buildings. | Value of railroads on surface. | Machinery. | Underground improvements. |
| | | | | | Males. | | Females. | | | | | | | | |
| | | | | | Number. | Wages paid. | Number. | Wages paid. | | | | | | | |
| Total | $80,712 | $50,835 | $45,945 | $1,305 | 5 | $3,525 | 1 | $60 | $24,193 | $5,684 | $2,361,017 | $19,745 | $1,600 | $121,550 | $335,982 |
| Albany | 42,469 | 25,392 | 22,702 | 1,130 | 2 | 1,500 | 1 | 60 | 11,972 | 5,105 | 409,670 | 7,850 | 1,100 | 14,900 | 141,200 |
| Carbon | 2,200 | 1,970 | 1,970 | ........ | ........ | ........ | ........ | ........ | 30 | 200 | 80,200 | 850 | ........ | 200 | 19,000 |
| Crook | 250 | 225 | 225 | ........ | ........ | ........ | ........ | ........ | 25 | ........ | 11,000 | 200 | ........ | ........ | 1,500 |
| Fremont | 25,637 | 15,061 | 12,961 | 75 | 3 | 2,025 | ........ | ........ | 10,340 | 236 | 1,070,147 | 7,695 | 500 | 105,800 | 109,612 |
| Laramie | 10,156 | 8,187 | 8,087 | 100 | ........ | ........ | ........ | ........ | 1,826 | 143 | 790,000 | 3,150 | ........ | 650 | 64,670 |

| COUNTIES. | VALUE OF MINING PROPERTY—continued. | | | VALUE OF MILL OR REDUCTION WORKS. | | | | MOTIVE POWER. | | | | | | | Number of animals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mine supplies. | Mine proper. | Cash. | Total. | Buildings. | Machinery. | Supplies. | Boilers. | | Engines. | | Other power. | Motors. | | |
| | | | | | | | | Number. | Horse power. | Number. | Horse power. | | Number. | Horse power. | |
| Total | $13,515 | $1,868,444 | $181 | $130,575 | $27,425 | $102,600 | $550 | 8 | 378 | 12 | 449 | ........ | 7 | 70 | 39 |
| Albany | 4 885 | 239,554 | 181 | 30,000 | 10,000 | 20,000 | ........ | 3 | 110 | 6 | 207 | ........ | ........ | ........ | 18 |
| Carbon | 100 | 60,050 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | 6 |
| Crook | 70 | 9,230 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Fremont | 8,075 | 838,465 | ........ | 78,575 | 7,425 | 70,600 | 550 | 4 | 208 | 4 | 177 | Water wheels, 4.<br>Whim, 1<br>Windlass, 1 | 7 | 70 | 13 |
| Laramie | 385 | 721,145 | ........ | 22,000 | 10,000 | 12,000 | ........ | 1 | 60 | 2 | 65 | Whim, 1 | ........ | ........ | 2 |

## NOTES ON THE CONDITION OF GOLD AND SILVER MINING.

Since the distribution of the production by states has not heretofore been very accurate, it is not possible to draw exact conclusions from a comparison of these figures with the output by states in earlier years, but some general lessons can be learned from them.

In Alabama, and in fact in all the eastern states, the gold production has not increased to any noticeable extent. The ores thus far worked have been chiefly low-grade "free-milling" ores, which have contributed but a small addition to the stock of gold. Since the reduction in the cost of treatment of gold-bearing pyritic ores, effected by improvements in metallurgical processes referred to in another part of this report, it is probable that the eastern states will increase their output, though perhaps not their relative importance as gold-producing states.

### APPALACHIAN RANGE: STATES OF VIRGINIA, NORTH CAROLINA, SOUTH CAROLINA, GEORGIA, AND ALABAMA.

In the states of the Appalachian range the majority of mines are small placer and river mines, producing insignificant amounts of gold. Of the mines listed in these states only 1 produced over $30,000 worth of bullion in the year 1889, 2 between $20,000 and $30,000, 4 between $10,000 and $20,000, 6 between $5,000 and $10,000, 11 between $1,000 and $5,000, and 47 less than $1,000 each. These 71 mines are distributed among the states as follows: Alabama, 6; Georgia, 22; North Carolina, 31; South Carolina, 7; Virginia, 5. Besides these mines there is a large number of small placers classed as petty mines, the production of which does not reach $100 each. The original list of names and addresses of mines to which schedules and letters asking for information were sent was so imperfect that only 16 schedules were received by mail direct from the owners of mines. These gave the statistics of the largest producing mines. Arrangements were made with Mr. Stuart W. Cramer, assayer in charge of the United States mint at Charlotte, North Carolina, to undertake a more thorough collection of the statistics of these states than could be done by mailing schedules to the owners of the mines. The following is an abstract from his final report:

> All mining that was not properly developing, or that which was so small that the production of bullion did not exceed $100 in value, has been included as petty mining. This petty mining also embraces the work by private individuals of handling the tailings from the larger mines. This was done so that the tables of cost, etc., would not be in error.

Attention should be called to the fact that certain managers reported (1) their net production, that is, what they get for it from the mint or assay office, not their gross output; (2) others sent their gross output, and (3) still others sent reports of output including petty work done on their property by private individuals, as reworking the tailings, etc., which is here classed as petty work. The figures on the detailed statement are correct, as will be seen by the close comparison with the estimate of the director of the mint (see pages 20 and 21 of the director's report). The data concerning the petty mining are included. This will be found very accurate as an average, though, of course, some localities have produced more and others less than that given. In the work use has been made not only of all the data that could be obtained from mine owners, managers, etc., but of the reports from all the mints and assay offices in detail, and also of all the data collected during a trip of 6 weeks spent in compiling the report on the production of the precious metals for my district; also all the data available from past experience with the section were used. To supplement and verify the foregoing all the important mining centers were visited by the special agent.

### PRODUCTION, BY COUNTIES, OF THE APPALACHIAN STATES: NORTH CAROLINA, SOUTH CAROLINA, VIRGINIA, GEORGIA, AND ALABAMA.

| COUNTIES. | Mines. | Amount. |
|---|---|---|
| NORTH CAROLINA | | $150,674 |
| Burke | Petty mining | 8,384 |
| Cabarrus | 2 mines | 15,500 |
| | Petty mining | 4,386 |
| Caldwell | Petty mining | 215 |
| Clay and Franklin | 1 mine | 180 |
| | Petty mining | 1,000 |
| Cleveland | Petty mining | 411 |
| Cleveland, Randolph, and Stanly | 3 mines | 45,386 |
| | Petty mining | 1,242 |
| Davidson | Petty mining | 100 |
| Guilford | ...do | 419 |
| Henderson | ...do | 214 |
| Iredell | ...do | 98 |
| Jackson | ...do | 150 |
| Lincoln | 1 mine | 622 |
| McDowell | Petty mining | 7,586 |
| Macon | ...do | 400 |
| Mecklenburg | 3 mines | 1,553 |
| | Petty mining | 5,051 |
| Montgomery | 6 mines | 24,924 |
| Moore | 2 mines | 2,295 |
| Nash | Petty mining | 3,033 |
| Polk | ...do | 761 |
| Randolph | ...do | 59 |
| Rutherford | ...do | 1,664 |
| Rowan | 2 mines | 1,897 |
| | Petty mining | 2,465 |
| Union | 3 mines | 9,157 |
| Warren | Petty mining | 500 |
| State, miscellaneous | | 11,022 |
| SOUTH CAROLINA | | $47,085 |
| Chesterfield | Petty mining | 110 |
| Chesterfield and Lancaster | 2 mines | 42,273 |
| Spartanburg | Petty mining | 669 |
| Union | ...do | 135 |
| State, miscellaneous | | 3,898 |
| GEORGIA | | 108,069 |
| Carroll | Petty mining | 315 |
| Cherokee, Haralson, and McDuffie | 3 mines | 18,165 |
| | Petty mining | 698 |
| Dawson | ...do | 648 |
| Forsyth | ...do | 130 |
| Habersham | ...do | 895 |
| Hall | ...do | 750 |
| Lumpkin | 7 mines | 27,414 |
| | Petty mining | 14,832 |
| Rabun | ...do | 1,041 |
| Warren | ...do | 86 |
| White | 3 mines | 23,318 |
| | Petty mining | 3,055 |
| Wilkes | ...do | 104 |
| State, miscellaneous | | 16,618 |
| ALABAMA | | 2,639 |
| Clay | Petty mining | 862 |
| Cleburne and Tallapoosa | | 777 |
| State, miscellaneons | | 1,000 |

## VIRGINIA.

The production of this state is so small and uncertain that it is impossible to locate it with any degree of accuracy, and therefore it is simply classified as "miscellaneous".

### ESTIMATES OF COST OF PETTY MINING, ETC., IN VIRGINIA.

| | |
|---|---|
| Amount of petty mining in bullion yield | $4,113 |
| Number of men engaged therein | 30 |
| Average number of days worked during the year | 90 |
| Total cost of supplies | $100 |
| Rent, taxes, etc., of the properties worked | $300 |
| Probable value of the properties | $50,000 |
| Probable value of the machinery and plant | $7,500 |
| Estimated daily earnings of the petty miners | $0.74 |
| Estimated yearly tribute of the property owners | $1,235 |

### ESTIMATES OF COST OF PETTY MINING, ETC., IN ALABAMA.

| | |
|---|---|
| Amount of petty mining in bullion yield | $2,639 |
| Number of men engaged therein | 25 |
| Average number of days worked during the year | 100 |
| Average daily earnings of the miners | $0.75 |
| Probable cost of these operations | $1,800 |
| Probable value of the properties | $60,000 |

It will be noticed that a slight change has been made in the list of items in the two preceding estimates. It is because most of the petty mining in Alabama is done by the property owners, who pay the miners and take the whole output of bullion, while in Virginia it is worked on shares independent of the development proper of the mines. On the whole, the estimates for these two states are very uncertain, and of such small proportions that they are comparatively unimportant.

### ESTIMATES OF COST OF PETTY MINING, ETC., IN SOUTH CAROLINA.

| | |
|---|---|
| Amount of petty mining in bullion yield | $913 |
| Number of men engaged therein | 15 |
| Average number of days worked during the year | 78 |
| Average daily earnings of these miners | $0.65 |
| Probable cost of supplies, etc | $33.48 |

### ESTIMATES OF COST OF PETTY MINING, ETC., IN NORTH CAROLINA.

| | |
|---|---|
| Amount of petty mining in bullion yield | $48,049 |
| Number of men engaged therein | 250 |
| Average number of days worked during the year | 160 |
| Average daily earnings of these miners | $0.80 |

### ESTIMATES OF COST OF PETTY MINING, ETC., IN GEORGIA.

| | |
|---|---|
| Amount of petty mining in bullion yield | $39,172 |
| Number of men engaged therein | 200 |
| Average number of days worked during the year | 150 |
| Average daily earnings of these miners | $0.85 |

In these states it is impossible to itemize more than has been done in the above, as the conditions are so different in various sections of the same state and there is such a large amount of petty work. The above figures show pretty well the amount of this work.

## ALASKA.

The report on mining in Alaska is furnished by Mr. J. H. Burfeind, special agent.

Alaska is so new and extensive a mining field that it may be expected to become a permanent, though perhaps not very abundant, source of supply. The ores thus far milled are chiefly low grade, occurring in large amounts, thus promising a permanent, though not rapid, increase. The gravel deposits, like those of all far northern countries, are of very limited extent.

Exact information respecting the actual amount of gold and silver produced in this territory can not be obtained. This refers especially to placer mining, which is carried on in a great many places beyond the reach of transportation, and at some places unknown except to the discoverers. Respecting quartz mining, more exact figures are obtainable. The deposits at mints and the reports from express companies are usually reliable guides as to certain facts, but neither can be so considered here. Most miners carry their gold dust themselves to market, to San Francisco (California), Portland (Oregon), or Victoria (British Columbia), and these respective states and provinces are credited with producing large amounts of gold which in reality come from Alaska.

Previous reports have been made relating to the earlier discoveries of placer mines. This description will be confined to what has been done since 1880.

### SILVER BOW BASIN.

The placer mines at this camp were discovered late in the fall of 1880. Many miners arrived during the following winter, and the present town of Juneau was started during 1881. A small amount of gold was produced that year, but the seasons of 1882 and 1883 were the best, and most of the best available ground was worked. Since that time much labor and the outlay of large sums of money have been required to get the ground into condition for working. During 1889 about $50,000 was produced, and fully eight-tenths of this by 2 private companies, in which men combined their labor and money. Even these 2 successful companies have lately sold their rights and interests to the Silver Bow Basin Mining Company. This company is now running a tunnel 2,600 feet long. The general opinion is that the company will take out more gold than has been taken out of the camp up to this time. The location warrants this to a certain extent.

Quartz mining in Silver Bow basin has been thus far unprofitable, not because there is no gold ore, but on account of the unsuitable works built there. There are ores in Alaska which can not be treated with profit by plant similar to that used at the Treadwell mine.

Between Silver Bow basin and Juneau is a syenite belt, and in it are found many veins. The Dora and Yukon Union group produced considerable gold considering the amount of work done.

### DOUGLAS ISLAND.

Placers were discovered here during 1881, and had produced about $50,000 when work was stopped. The working of these placers laid bare a very large body of low-grade quartz, which was located as the Paris mine, which the owner, not considering of much value, sold, with a few adjoining claims, to Mr. John Treadwell for a few hundred dollars. The quantity of ore was satisfactory, but the average quality had to be learned, and development work was started at once in a systematic way. As soon as Mr. Treadwell and his associates were satisfied that with proper works the ore would yield a good profit they began building a 120-stamp mill. After this mill had run successfully for several years another 120 stamps were added, and not one of these stamps has remained idle a day for want of ore; however, 4 or 5 days have often constituted a month's run on account of scarcity of water. Steps are being taken to avoid this trouble. The ore body, where it is worked at present, is above 550 feet wide and is quarried in open pits, a few power drills being ample to break 600 tons daily. No assorting is done, everything between the walls going to the mill. The ore consists mainly of quartz and calcite, carrying free gold and gold-bearing iron pyrites. The free gold is amalgamated in the batteries and on plates in front of them, and whatever gold or amalgam may escape from the plates is saved in mercury traps. The pulp, thus freed from the metallic gold, goes to the Frue concentrators, where the gold-bearing pyrites are separated from the worthless gangue and the concentrates are taken by tramway to the roasting furnaces, on the top of which they are dried.

There is 1 reverberatory, 13 feet by 65 inches, inside measure, and 6 double Hammond-Spence furnaces. The gold is extracted from the roasted material by the Plattner process. Of the gold in the raw sulphurets 93 per cent is found in the melter's bar ready for shipment, the loss being only 7 per cent.

There are other producing mines on Douglas island. The Mexican group, adjoining the Treadwell on the southeast, now being opened, is expected soon to enter the list of producers.

### SHEEP CREEK.

This camp has only come into notice since 1888. The Silver Queen is the only producing mine yielding a high-grade silver ore. It contains some gold also. The first-class ore is shipped, while all ores under $100 per ton assay value remain on the dumps awaiting some other treatment. The shafts and tunnels on this property show the ore bed to be uniform in size and quality. There are several other claims on this ledge that have good indications. The Gould and Currier claim is a different ledge, and the ore carries principally gold, with a small amount of silver. Not enough work has been done to demonstrate the extent of the ore body, but the ore taken out for the purpose of development is sufficient to more than pay for the money expended, which can be said of only a few mines. It is to be hoped that the different owners of claims in this camp will continue to work, as by doing so they have every indication of meeting with success.

### SUMDUM BAY.

In the summer of 1889 two good discoveries were made here. On the Sunnyside lode is found a purple copper ore (bornite) carrying up to several hundred ounces of silver per ton. At another part of the bay rich gold ore was discovered late in 1889. A mill run made by Mr. Thomas Price at San Francisco shows that the ore averages $300 per ton in gold, and the test made indicates that it can be worked very cheaply. The owners are diligently investigating their discovery.

### GLACIER BAY.

Silver-lead ores have been discovered here, but as yet work has been insufficient to demonstrate the value of the discovery.

### ADMIRALTY ISLAND.

The large bodies of low-grade ore found here have, as far as investigated, proved too low in gold to justify working. At Funter bay, on this island, small veins of good grade gold ores are found, but further development work is necessary to determine quantity and quality, and the discoverers and owners are now erecting a small Huntington mill.

### BERNERS BAY.

This district was entirely neglected in 1889, nothing but assessment work having been done. It is to be hoped that the promising properties here will receive more attention, as the work on the Comet, little as it is, shows a good body of excellent ore, and the work on the Uncle Sam and Golden Brown, which exceeded the necessary assessment work this last season, has met with results sufficient to encourage other owners of claims.

### YUKON.

The discouraging reports about unwholesome provisions and the difficulties encountered in getting to Yukon and back have deterred miners from going there, but those who have settled down to work appear to do very well.

At Snettisham bay good ore is said to have been found, but there is no information regarding the claims worked, which indicates that the few miners have met with good success, especially when the difference between the production of 1880 and 1889 is taken into consideration.

Nothing like actual facts regarding the production of placer gold from the Yukon region can be obtained. Mr. W. F. Reid thinks, to judge from the amount of gold brought out by way of Juneau, that every man had an average of $800, and thinks there are fully 175 miners at work there, which would indicate a production of $140,000 annually. It should be placed very much lower, however, as those who actually worked usually returned by way of Juneau, while those who prospected all along the river mostly returned by way of San Francisco, and with very little gold. The actual proportion of the 175 who are miners and actually at work is not, however, known, and $75,000 will doubtless fully represent the output last year.

## ARIZONA.

Arizona contains great possibilities, though the output has been almost stationary for many years. The climate is less favorable than in some other sections, and the lack of railroad communication to many promising districts has retarded the development of what will eventually become an important factor in both gold and silver production.

## CALIFORNIA.

California, the great pioneer in the gold-producing industry, is of all the states unquestionably the most liberally supplied by nature with this metal. Its placers are the most extensive and richest that have ever been discovered, and they are still far from being exhausted, though many of the most important and accessible beds have been washed over. The recent antidébris legislation in California forbidding the working of hydraulic mines has lessened the production of the metal and threatens the almost entire destruction of this very important industry. In its silver production California has for years been almost stationary.

The following is an abstract from a particularly valuable contribution made to the director of the mint by Mr. Charles G. Yale, who was also the special agent of the census for this state:

> The principal mining industry of California is that connected with the extraction of gold from quartz and gravel, and the state still continues to hold first place in the list of states and territories in the matter of gold product from year to year. In the earlier history of gold mining in California the main portion of the precious metal was procured from the placers or surface washings in the gulches, cañons, and river bars and beds, and for many years an enormous yield was maintained from these sources. Gradually, however, as was to be expected, the area available for this kind of mining was narrowed as ground was worked out, and then attention was turned to other sources of gold supply.
>
> Finding, as the miners of those days did, these auriferous deposits only at certain points, they very naturally looked near by for the source of the free placer gold. This led to the search for quartz veins, and also for the large bodies of auriferous gravel which were contained in the hills of the mining counties of the state. In time the gravel deposits were found and located and the quartz ledges opened and developed. Then the character of the mining and the character of the mining population changed. It was no longer possible for a nomadic miner with pick and pan to gather a fortune in a few days from a deposit which nature had concentrated for him in a few yards of earth. It became necessary to employ capital as well as labor in the mining operations of the state. Companies took the place of the individual miner, built ditches to bring in water to the gravel claims, and mills to crush the ore from the quartz veins. The miners gradually stopped working for themselves and were employed by the companies for daily wages. They became more settled in their habits, gave up their nomadic instincts, and became permanent residents of the little mining camps and larger mining towns, where they were sure of steady employment in the mines or mills. Of course there are still many prospectors in the mountain counties as well as miners who are working their own claims, but the majority of the mining population is now engaged in work for the companies, who are operating the mines on a more extensive scale than is usually possible for individuals.
>
> The era of speculative mining incidental to newly-settled mining regions has also passed by in California.
>
> It may be confidently stated that the quartz industry of the state is in a better condition to-day than it has been since its inception. The appliances for saving gold which have been perfected are applied intelligently and carefully, and every effort is made to gain a large percentage of the gold that is in the ores. The sulphurets are no longer allowed to go to waste, but all mills are now supplied with concentrators for saving this valuable product for subsequent treatment. Some of the larger mills have their own chlorination works for treating sulphurets, but those which have not find no difficulty in disposing of the concentrates to establishments which make a specialty of working them. The value of the sulphurets is usually subordinate to the value of the free gold in the ores, but in the total product form an important factor. The average value of the sulphurets saved in the state may be placed at from $80 to $90 per ton of concentrates, but it, of course, may take many tons of ore to yield a ton of these concentrated sulphurets. The percentage of sulphurets will vary from 1 to 5 of the ore milled. These sulphurets are iron pyrites principally.
>
> What are termed low-grade ores vary in value from $3.50 to $8 per ton in gold, and high-grade ores are those yielding from $15 to $30 per ton. The average value of the ore treated at present may be stated at $10 to $12 a ton. In the low-grade ores the gold can seldom be seen with the naked eye, but the high-grade ore often shows particles of free gold. Mineralogically the ores worked consist generally of a quartz gangue, carrying free gold and iron pyrites. Quartz is the characteristic matrix of the veins, though other matrices occur.
>
> The milling of gold ores in California has been greatly perfected of late years, and it is now possible to work ores profitably that 10 years since were practically worthless. This has come about by the adoption of more economical methods in both mine and mill and greater care in the handling of the ore, as well as increased knowledge of the proper way to treat the ores in the mill. Improved appliances are also important factors. The present form of stamp mill combines durability of construction with an automatic simplicity in the manipulation of the ores. The important object in the treatment is to secure the largest yield consistent with the least waste of the precious metals by the adoption of the most rapid, simple, and economical method of reduction and amalgamation.

Briefly, the process of treatment may be described as follows: The ore from the mine is conveyed to a chute above the rock breaker floor, where it is discharged upon a grizzly, which consists of an arrangement of iron bars framed and inclined downward and so set as to permit only the smaller and suitable-sized fragments to fall into the ore-feeder bin below, while the larger masses slide down over the grizzly to the rock breaker, which crushes them to proper dimensions and discharges them into the ore-feeder bin and hopper. From here they are automatically fed as required to the battery stamps in the mortar, where they are pulverized, and quicksilver being introduced to the pulp an amalgamation of the freed particles of gold is accomplished and the resulting amalgam retained on the silver plates fitted within the mortar.

A suitable amount of water is introduced into the battery with the ore, and this, with the "swash" of the stamps, forces the ground pulp and amalgamated particles through fixed screens out of the mortar upon an inclined table or apron of such a width as to permit a thin stream of water and pulp over the silvered plates with which this apron is covered, where the stray amalgam and liberated particles of gold are caught. The remaining sands flow on concentrators, which by their peculiar action retain the heavy and metallic particles and discharge the lighter and worthless portion. Where water power is abundant this waste, or "tailings", is sometimes again worked in arrastres to catch anything which may have passed the appliances described. The concentrations caught in the concentrating machines are accumulated in proper receptacles and retreated, either by further pulverization and amalgamation in grinding pans and settlers or by chlorination or other process, as the character of the chemical combinations may require.

Although some of the sulphurets obtained by the concentrators are treated at smelting works, most of them are treated in California by the Plattner chlorination process. This consists in roasting the concentrates in reverberatory furnaces to drive off the sulphur, arsenic, and other deleterious substances. Salt is added as the roast nears completion. The thoroughly roasted and moistened concentrates are charged into impregnation vats, through which chlorine gas is passed. The chlorine gas attacks the gold, forming with it terchloride of gold. Then water is added to the vats, by which the terchloride of gold is leached out. The lixivium is run into precipitating tanks, where, by the addition of a solution of sulphate of iron, the gold is precipitated. The gold is collected upon filters, thoroughly washed, dried, and melted. The chlorination gold averages from 0.999 to 0.9995 fine. If there is silver in the concentrates, as often happens, it is leached out and reduced to a metallic state. A chlorination plant with a capacity of 6 tons in 24 hours costs from $6,000 to $7,000, and it will cost such a plant about $10 a ton to treat the concentrates. From 90 to 92 per cent of the gold value of the concentrates is recovered. At all important mining points in the state there are now custom chlorination works, which charge about $20 per ton for treatment and guarantee about the above-mentioned percentage of returns.

Machinery for concentrating the sulphurets has attained considerable perfection of late years, and there are many forms on the market. The most popular and generally used are those forms which employ an endless rubber belt, near the head of which the pulp is fed. The belt is slightly inclined and is given a shaking motion, so as to keep the particles in agitation. The sulphurets settle on the belt, and, adhering to it, are carried over the head of the table and deposited in a tank or box beneath. The specifically lighter particles are carried downward and pass, as "tailings", to the blanket sluices outside the mill. These are the general features of this class of machines, which, however, vary in details of construction and operation to some extent, and each kind has its advocates. Many mills have from 100 to 200 feet of blanket sluices with a grade of from 1 inch to 1.25 inches per foot, and the stuff, after passing over the concentrators, is led to and flows through these blanket sluices. The sands collected on the fibers of the blankets are usually ground in a pan used for that purpose, though essentially like those used in silver mills.

The introduction of rock breakers and automatic ore feeders has greatly increased the effectiveness of stamp mills as compared with breaking rock and feeding the battery by hand. The use of the feeders is considered to have increased the capacity of the battery from 15 to 20 per cent, besides effecting a very considerable reduction in the wearing of screens, dies, shoes, etc. As to the duty of stamps, the number of tons crushed depends on several things, but chiefly upon the character of the ore. Hard ores and those of a clayey nature decrease the duty of the stamps. The average duty of the stamp in this state is approximately 2.25 tons of ore in 24 hours. Within a short time a great improvement has been made in the matter of steel shoes and dies for quartz mills. Formerly, owing to their tendency to chip and cup, their introduction met with little success. In most mills, where transportation is an important element in the cost, steel shoes have replaced the iron ones formerly used. Recently chrome-steel shoes and dies have been introduced and have proved their superiority over most other kinds of steel used. In some mills steel shoes and iron dies are used. The iron dies wear more evenly with steel shoes than the steel dies do. The life of the steel is about 2.5 to 3 times that of iron shoes and dies, and the cost about twice as great as that of iron.

In the matter of plates for the aprons of gold mills silver-plated copper has almost everywhere superseded the ordinary amalgamated copper plates. They are more easily kept clean and the coating of amalgam that forms is very effective. In fact, there is a constant absorption of amalgam by the plates. At the Empire mill, Grass Valley, Nevada county, notwithstanding the fact that the plates were well cleaned every day, the "sweating" of the outside battery plates and the aprons from 4 batteries yielded $19,000 worth of amalgam after 1.5 years' run.

The loss of quicksilver per ton is variable. 1 ounce per 2 tons of ore (1 pound for 32 tons) is about the mean quicksilver loss for the mills of the state. The quicksilver loss occurs generally through its being "floured" and floated off with the water in extremely finely divided particles.

As to percentages saved and cost of milling gold ores, Mr. John Hays Hammond, M. E., an authority on this subject, says:

> The average value of the ore worked is the value of the gold saved, plus the value of the sulphurets saved plus the value of the tailings lost. From these factors is calculated the percentage of gold saved by the mill. This represents the efficiency of the process. Other things being equal, this will vary with the character of the ore. Where the gold is very fine and where the sulphurets are of a brittle character the percentage saved will be less than in the treatment of more favorable ores. Most of the loss occurs in the loss of sulphurets, consequently ores carrying a large percentage of rich sulphurets may have comparatively rich tailings. There are few ores in mines in operation in California from which 80 per cent and upward of the assay value can not be extracted by skilled mill men with good mills. The majority of mills save at least 75 to 85 per cent of the assay value of the ores. Careful investigation at the North Star and Empire mills, carried on for 1.5 years, shows a saving of from 82 to 94 per cent of the assay value. The usual percentage saved, according to reliable semimonthly reports from these mills, is from 86 to 90 per cent of the assay value of the ores. In these estimates of course no deduction is made for the loss of gold in the subsequent treatment of the sulphurets, usually unimportant in this connection.

USUAL COST OF MILL LABOR IN CALIFORNIA PER 24 HOURS.

| | |
|---|---|
| 1 man at rock breaker, at $2.50 | $2.50 |
| 2 amalgamators, at $3 | 6.00 |
| 3 concentrators, 1 at $3 and 2 at $2.50 | 8.00 |
| Total | 16.50 |

The rock-breaker man also attends to the blanket sluices, and is employed in other tasks about the mill. Where steam power is employed in addition to the above force, 2 engineers and 1 man to pile the wood near the boilers, etc., are required.

The following is the usual cost of milling per ton in a 40-stamp gold mill (water power) with a capacity of 80 tons per 24 hours:

COST PER TON OF GOLD MILLING IN CALIFORNIA.

| | |
|---|---|
| Labor: | |
| Mill labor | $0.205 |
| Assaying, retorting, and superintendence | 0.025 |
| Total | 0.230 |
| Supplies: | |
| Castings | $0.070 to $0.100 |
| Quicksilver | 0.015 to 0.040 |
| Lubricants, screens, illuminants, machinists' time, incidentals | 0.040 to 0.080 |
| Total | 0.355 to 0.450 |

To this must be added the cost of water power, which is very variable. Where steam power is used the above estimate should be increased about 10 cents per ton for labor. Repairs, lubricants, etc., incident to the use of steam-power plant increase the cost about 1 cent per ton. An electric plant to illuminate the mill, the office, etc., costs about $600. The cost of producing the light is but little beyond the cost of power to run the dynamo. Good illumination is very desirable about a mill. The charge for assaying, retorting, and superintendence is based upon the salary of $120 per month for a man to perform these duties, in addition to rendering other services, that is, clerk, timekeeper, etc., about the mine. One half of his time is charged to the cost of milling, while the other half is charged to the cost of mining. At some works the superintendent of the mine performs these duties.

Although the ordinary stamp mill still continues to maintain its prestige for the reduction of ores in California, it is proper to state that within the past few years various forms of roller mills and other forms of pulverizers have been largely put into use, especially on small mines, where the owners were unwilling or unable to go to the expense of erecting stamp mills. There are several types of the pulverizers, varying more or less in principle, but forming in themselves complete ready-built mills, simply needing a foundation to be ready for work. These cost much less than stamps, and have been found very effective on certain classes of ores. In fact, their use is increasing gradually, as they are well adapted for prospecting mills and for mines owned by individuals or small companies. There are some persons who advocate their use in preference to the stamp, while others do not believe in anything but the stamp for crushing ore. However, numbers are made, sold, and put into use, and in certain instances their effectiveness can not be doubted.

As to the extent of the quartz industry, some idea may be given from the appended list of quartz mills, as this list will show the relative importance of the different counties of the state. It should be borne in mind that the larger portion of the mills enumerated are only run during the water season, and some are "custom mills", which run whenever supplied with ore. As most of the California mills are run by water power, it will be understood that unless other power is mentioned water is employed.

QUARTZ MILLS.

| COUNTIES. | Mills. | Number of stamps. | Remarks. | COUNTIES. | Mills. | Number of stamps. | Remarks. |
|---|---|---|---|---|---|---|---|
| Amador | Amador gold | 60 | | Eldorado—cont'd. | Josephine mine | 20 | |
| | Amador Queen | 20 | | | Linden gravel | 10 | |
| | Bunker Hill | 40 | Water or steam. | | Melton | 15 | |
| | Gover | 20 | | | Oregon | 10 | |
| | Kennedy | 40 | | | Pacific | 20 | |
| | Keystone | 40 | Water or steam. | | Rogers gravel | 10 | |
| | Lincoln | 40 | | | Superior | 10 | Steam. |
| | Live Oak | 2 | | | T. Taylor | 10 | |
| | Loyal Lead | 10 | | | Vandalia | 5 | Steam. |
| | Mahoney | 40 | | | Zentgraft | 10 | |
| | Moore | 10 | | Fresno | Abbey | 10 | Steam. |
| | Nevills | 10 | | | Confidence | 5 | |
| | Oneida | 10 | | | Hanover | 5 | Steam. |
| | Plymouth Consolidated Mining Company. | 160 | | | Josephine | 20 | Do. |
| | | | | | Last Chance | 10 | Do. |
| | South Spring Hill | 30 | | | Providence | | Steam, Dodge pulverizing mill. |
| | Sutter Creek | 10 | | | | | |
| | Wildman | 10 | | | Samson | | Steam, Kendall mill. |
| | Zeile | 40 | Water or steam. | Lassen | Evening Star | 10 | |
| Calaveras (*a*) | Blazing Star and Water Lily | 8 | Steam. | | Golden Eagle | 5 | |
| | Esmeralda | 10 | Do. | Los Angeles | O'Reilly mine | 5 | Steam. |
| | Ilex | 40 | Steam and water. | Mariposa | Cranberry | | 2 arrastres. |
| | McCreight | 10 | | | Hathaway-Bondurant | 10 | Steam. |
| | Russell Reduction and Mining Company. | 5 | Steam and water. | | Hite | 40 | |
| | | | | | Red Cloud | 22 | Steam. |
| | Sheep Ranch | 30 | Steam. | Mono | Monte Cristo | | Steam, 2 Huntington mills. |
| | Stickles | 20 | | | | | |
| | Suffolk | 5 | | | Standard Consolidated | 15 | Steam. |
| | Utica mine | 60 | | Monterey | Last Chance | 3 | Do. |
| Colusa | Manzanita gold mine | 10 | Steam mill. | Napa | Palisade silver | 10 | Do. |
| Eldorado (*b*) | Alpine | 10 | | Nevada | Blue Bell | 10 | |
| | Big Canyon | 20 | | | Brunswick | 20 | Steam. |
| | Chili Ravine | 10 | | | Champion | 10 | |
| | Church | 10 | | | Champion | | 1 Huntington mill. |
| | Gopher and Boulder | 20 | | | Crown Point | 10 | |

*a* The Maltman reduction works, run by steam, have also 1 Tustin pulverizer; the Russell Reduction Company, 1 Dodge ore pulverizer; Angels mine, 3 low pulverizers; Quaker Hill, 1 6-foot Huntington mill; Buena Vista (steam), 1 Kendall rocker mill.

*b* The Shaw has a 5-foot Huntington pulverizer, and the Mathines Creek a 5-foot mill of the same pattern.

QUARTZ MILLS—Continued.

| Counties | Mills. | Number of stamps. | Remarks. |
|---|---|---|---|
| Nevada—cont'd | Delhi | 18 | |
| | Empire | 40 | |
| | Excelsior | 10 | Steam. |
| | Gaston Ridge | 10 | Do. |
| | Idaho | 35 | |
| | Larimer | 10 | |
| | Mayflower | 4 | |
| | Nevada | 10 | |
| | North Banner | 5 | |
| | North Star | 30 | |
| | Omaha Consolidated | 10 | |
| | Orleans | 8 | Steam. |
| | Rocky Glen | 10 | |
| | Rodgers | 10 | |
| | Spanish | ........ | 4 Huntington mills. |
| | Washington | 20 | |
| | Yuba | 15 | |
| Placer | Bells | ........ | 1 Kendall rocker mill. |
| | Breece & Wheeler | 10 | Steam. |
| | Buttes | 5 | |
| | Dardanelles | 5 | |
| | Dorer | 10 | |
| | Jamison | ........ | Arrastres. |
| | Kidd & Johnston | 5 | |
| | Live Oak | 5 | |
| | Morning Star | 10 | Steam. |
| | New | 5 | |
| | Saint Patrick | 15 | |
| | Shipley | 10 | |
| Plumas | Crescent | 16 | |
| | Green Mountain | 60 | |
| | Kettle Mill | 20 | |
| | Plumas Consolidated | 24 | |
| | Plumas Eureka | 60 | |
| San Bernardino | Barbero | 10 | Steam. |
| | Hawley | 10 | Do. |
| | Waterloo | 60 | Steam, new. |
| | Waterloo | 15 | Steam, old. |
| San Diego | Ready Relief | 10 | Steam. |
| | Stonewall | 10 | Increased to 30. |
| Santa Cruz | Stribling Mill | 5 | Steam. |
| Shasta | America | 5 | |
| | Calumet | 24 | 2 Paul dry pulverizers. |
| | Celestine | 5 | |
| | Central | ........ | 2 Huntington pulverizers. |
| Shasta—cont'd | Gem Consolidated | 10 | Steam. |
| | Lost Confidence | 20 | Do. |
| | Majara | 18 | Do. |
| | Reilly & Bliss | 10 | |
| | Uncle Sam | 10 | Now 50 |
| Sierra | Gold Bluff | 12 | |
| | Rainbow | 10 | |
| | Sierra Buttes | 80 | |
| | Young America | 40 | |
| Siskiyou | Black Bear | 32 | Water and steam. |
| | Caribou | 2 | |
| | Comstock No. 2 | 5 | Steam. |
| | Daggett & Smith | 5 | |
| | Evening Star | 4 | |
| | Hooper's Custom | 5 | Steam. |
| | Johnson's Oro Fino | 10 | |
| | Luna | 4 | |
| | Methodist Creek | 1 | |
| | Mount Laurel | 16 | |
| | Schroder & Warner | 5 | Steam. |
| | Scott Bar | 10 | |
| | The Cilta | 4 | |
| | Uncle Sam | 8 | |
| | Warren & Green | 5 | |
| Trinity | Bartred | 10 | Steam. |
| | Brown Bear | 15 | Do. |
| | Bullychoop | 5 | Do. |
| | Golden Chest | 5 | |
| | North Star | 5 | |
| Tuolumne | App | 5 | |
| | Belcher Consolidated | ........ | Steam. Kendall oscillating mill. |
| | Black Oak | 10 | Steam. |
| | Buchanan | 20 | Do. |
| | Consolidated Eureka | 20 | |
| | Experimental Gulch | 10 | |
| | Gem | 10 | |
| | Heslep | 25 | |
| | Hidden Treasure | ........ | Steam, Huntington pulverizer. |
| | Kanaka | 5 | |
| | Madrid | 5 | |
| | New Albany | 10 | |
| | Patterson | 20 | |
| | San Guiseppa | ........ | Arrastres. |
| | Seeber | 15 | |

Idle or inactive mills are not included in this list. Additions are commonly made to the number of stamps as the mine development and output of ore demand.

One reason for the increased activity in quartz mining in California of late years is the very general adoption of water power as a motor, thus cheapening operations. In most of the mining sections water is available, and the storage reservoirs built by the hydraulic miners are now utilized for water supplies to the quartz mines. As a general thing this water is brought in with a high head or pressure, so that there is plenty of power. This feature has had the effect of bringing to a profitable point quartz ventures that were not paying when steam was used.

It is worthy of note that many mines abandoned years ago have been reopened and worked recently, the conditions having changed. In the first place, the miners can work ore much more cheaply than in former years, and supplies are cheaper, means of transportation better, and knowledge of mining increased. The Stonewall mine, in San Diego county, for instance, was abandoned for 10 years and filled with water. It was purchased by the governor of the state, who reopened the mine and equipped it with a fine milling plant and other improved machinery, so that it is very profitable. Many other instances of a similar character might be cited.

Hydraulic mining was at one time the source of a large annual output of gold in California, and millions of dollars were invested in the mines, reservoirs, ditches, flumes, and plants. Litigation arose between the mine owners and the owners of lands along the rivers below the mines, owing to the débris or tailings from the mines injuring the farming lands and navigable rivers. Long-contested trials resulted in most of the mines being closed down under injunction by the United States courts, and they still remain idle. These injunctions affected the hydraulic mines in the tier of counties extending from Shasta to Calaveras. However, the counties of Siskiyou, Trinity, and Del Norte, in the northwestern angle of the state, have many hydraulic mines in operation, and this is the principal branch of mining carried on there. The conditions for this branch of mining are exceptionally good along the Trinity and Klamath rivers and their tributaries. In that region there is no valid objection to hydraulic mining being carried on, the streams not being navigable and the débris question not being an important one. During the past 4 or 5 years hydraulic mining operations have increased in the 3 counties mentioned, and large extents of ground are being developed with first-class plants.

Owing to the practical stoppage of this class of mining in large portions of California, no improvements of note have been made of late in the methods of carrying on the operations.

In some places this kind of mining is carried on in a small way by using what are called débris dams. These dams are obstructions placed across the beds of streams for the purpose of holding back the sand and gravel coming from the mines to prevent their entering into the navigable streams and damaging the land in the valleys below. They are placed either in the mountain cañon or in the valleys where storage room can be conveniently arranged. The dams are made of stone, wood, or brush, as circumstances require. The structures are not designed to impound water, but simply to check the velocity of the current carrying the mining and other débris and to allow the deposit of the material behind them, and therefore they partake more of the character of retaining walls than water dams. Some large mines which built débris dams were also enjoined from hydraulic mining by the courts, notwithstanding the dams, on the ground that the waters of the streams were muddied by the overflow waters from said débris dams, all the matter in suspension not having been precipitated and retained. A commission of United States engineers, under instructions from Congress, is now engaged in examining into the whole question of hydraulic mining in California and its effects upon the streams, with a view of finding the actual damage done by the débris from the mines, and also to see if there is any practicable way to permit the mines to be worked without damage to property or rivers. This commission will make a report to Congress on the subject. In hydraulic mining water is made to do the work of moving the material by being brought under heavy pressure and in large volumes against the gravel banks. These banks are first shaken or loosened by heavy blasts of powder, and when the water is turned through the nozzles against the bank the gravel is torn down and washed through the long line of sluices, undercurrents, etc., and the gold caught, the débris or tailings passing on into the cañons, streams, and rivers. The heavy portion soon comes to rest, but the lighter sands often go for some distance before being deposited, and it is these sands, filling up the rivers, which brought about the "débris question" in California.

It is a very expensive operation to equip one of the claims, because the gravel bank is worthless unless an abundance of water can be supplied. Therefore the companies must construct reservoirs, ditches, flumes, etc., and lay a line of pipe to bring the supply under pressure to the point where it is to be used. Then, again, very expensive bed-rock tunnels must also often be made to get rid of the tailings, for there must be "fall" for this débris to pass on out of the way. For these reasons the business of hydraulic mining is generally carried on by companies of capitalists, the expense of opening and equipping one of these mines being beyond the means of the individual miner or prospector.

Before the injunctions of the courts stopped the large hydraulic mines of the state a machine was in use for working shallow banks and low deposits in basins and creeks, called the hydraulic gravel elevator. Many valuable auriferous deposits are found in basins and flats lying along creeks far too low to be underrun by bed-rock tunnels, open cuts, or drains at any cost, and these deposits had to be worked by shovels and barrows, whims, engines, derricks, and pumps. To overcome these difficulties and to dispense with the use of expensive pumping plants, the hydraulic elevator was devised and put in use. It was at first looked upon with some doubt as a practical apparatus to do any work on a large scale; but when the large mines were prevented from working by the ordinary hydraulic method this appliance was tried in these claims and has been found to answer the purpose of working them, though on a more limited scale than was practiced by the old method.

The principle upon which the operation of these hydraulic gravel elevators is based is that of driving gravel up hill by hydraulic force. It is only necessary to give the impelling water more velocity than it has through an ordinary flume to make it acquire sufficient force to carry gravel up an inclined plane. This fact suggested the construction of a form of machine which should so direct and confine the inherent hydraulic force of a stream of water as to impel before its power masses of earth and gravel.

These hydraulic gravel elevators are simple in construction. An inclined pipe or closed box, open at upper and lower ends, is placed in position and the open end of the ground section is concave in shape, or a lower half-section of pipe flaring outward, into which earth, sand, and gravel are sluiced by hydraulic giants through bed-rock flumes leading thereto. This lower end is set into a chamber or hole excavated below the surface bed rock. The material sluiced into this lower entrance is taken up by a stream issuing from a fixed hydraulic nozzle, which by its force impels it upward through the pipe to its point of discharge into the open flume above, whence it is carried away through a line of sluices to a final dump. Confined as the material is within this tight iron box, it goes as fast as the stream itself, and as the gravel is acted upon by the full force of the water from the hydraulic nozzle the gravel is disintegrated by this action. The practical operation of these machines has determined the fact that when properly and advantageously set and operated the amount of water and material which can be raised and impelled through the upraise pipe is governed and limited only by the volume of water used, acting under its given head or pressure, and the carrying capacity of the pipe. The character of the gravel deposits, whether good piping ground or hard, compact conglomerate, governs the size of the hydraulic giants used, and consequently the quantity of water requisite for piping purposes. The greater the pressure and volume at command the larger the quantity of earth and gravel that can be raised.

These machines are being worked in various parts of the state, where the vast areas of ground which have been piped out in the past are utilized as reservoirs for impounding the débris which may be hydraulicked by the elevator system. The gravel from the standing banks is washed down by giants, sluiced to the elevator, and forced up, as described, to such points that it may be led to old workings or pits and there retained, and not flow into the streams, the gold being retained in the sluices and other gold-saving appliances. Without this apparatus for elevating and throwing back the débris many mines would be unable to impound their débris without very great expense, since old workings can be utilized as débris reservoirs.

The future of drift mining in California is promising. The better knowledge of the character and situation of the buried auriferous channels and the more systematic methods of exploration and mining have taken away much of the uncertainty which caused so many failures among the earlier drift-mining operations.

River bed and bar mining are not so common in California as in early days, most of the rich bars on the rivers having been worked out. In some places, however, these bars are being worked over and over whenever the stage of the water permits. Up on the Klamath, in Siskiyou county, there is still a great deal of river mining going on, the miners using the old-fashioned "wing dams" and wheels to get at their claims. There is more of this class of work now going on in the extreme northwestern counties than elsewhere in the state.

Several attempts have been made in the last few years to turn aside an entire river in order to get at the gold in the bottom, but none of these large enterprises have so far been successful. On the Tuolumne river, near Jacksonville, a short distance from Chinese Camp, a large amount of money was expended in building a dam and flume to get at the river bed, and although about $16,000 was obtained in one hole 5 feet deep and prospects looked well, the waters washed away the dam and flume and the investment was lost.

On the Big Bend of the Feather river, Butte county, the Big Bend Mining Company ran a tunnel about 12,000 feet long (which, being found to be too small, was enlarged in dimensions to 13 by 16 feet), built a dam, put in sluices, pumps, electric plant, and spent immense sums in laying bare some 14 miles of the river bed, but no returns have been received, and the projectors report the enterprise a failure. On the same river and above this claim the Golden Gate Company built a dam 50 feet high, a flume 50 feet wide and 3,300 feet long, and were about to begin work in the exposed river bed, when a sudden rise in the river washed away the dam and flume and stopped operations. A new dam and flume will be built this year and work started over again. Many people believe that large amounts of gold will be taken out of these claims, but thus far, notwithstanding all the money spent and precautions taken against accident, none of these enterprises have been successful.

Two notable discoveries have been made in the coast range within the past few years, and the old theory that there would be no gold mines of value in that range has been disproved. Los Burros district, in the southern end of the Santa Lucia range, Monterey county, was first worked for quartz in 1887, and now there are some 25 claims, of which the Cruikshank is the most important. The ore is free milling, containing both silver and gold, the latter predominating. Placer gold is also found, which is rough and angular, evidently coming from the ledges near by. A number of men are now at work in this district.

In Napa county, on the lower slopes of Mount Saint Helena, silver mines have been found, and one, the Palisade, has a 10-stamp mill in operation. The ore produces about 30 ounces a ton.

The silver-mining interests of California are small as compared with the gold. Silver ore is found in the following counties of the state: Alpine, Mono, San Bernardino, Napa, Fresno, Kern, San Benito, Sierra, Siskiyou, and Inyo. The principal silver district is that of Calico, San Bernardino county.

## MINES AND MINING IN PLACER, SIERRA, AND YUBA COUNTIES, CALIFORNIA.

The following report is furnished by Mr. R. L. Dunn, special agent:

### PLACER COUNTY.

The mines and mining industry of this county is divisible for detailed consideration as follows: (1) gold-bearing quartz mines; (2) gold-bearing drift placer mines; (3) gold-bearing hydraulic placer mines; (4) river bed and bar placer mines; (5) tailing placer mines; (6) surface placers and the rocker and sluice mining of placers on a small scale without plant. Their relative importance is as stated in the order of the classification, except that at the present time drift mining may be of somewhat greater magnitude than quartz mining. Each of the 6 kinds of mines is in turn divisible into 3 groups, viz: (1) locations and mining claims not yet developed and on which there has been little or no expenditure, and in many instances will be no more; (2) mines either producing or being actively developed to the producing point, including mines on which there has been expenditure, but whose permanent development work is being done on adjacent mines; (3) mines that are worked out and practically abandoned. The schedules returned by the special agent have been of mines of the second class or kind only. There are probably twice as many locations and claims in the first class of which no account has been taken, as they have produced nothing, and not to exceed $5,000 in the aggregate was spent on the entire number in 1889. Their inclusion would only increase the values on estimates built on nothing more substantial than hopes and make a false proportion between values and production and expenditures.

Drift mining as an industry has certain peculiarities as to values that make an explanation pertinent. The underground improvements, tunnels, drifts, etc., are very largely made in connection with the mining out of the ground, the first dead expenditure of opening in many instances being nominal, and then the extension of the tunnels and drifts is paid for out of the product of the mine as a current expense account rather than an investment of so much capital. A drift-mine tunnel may be 10,000 feet long, costing $100,000, yet it only represents the expenditure of $5,000 of capital, the remainder of the money having come from the current product of the mining. The mine of course lessens in value as the ground is more and more worked out, yet the extent and expenditure of necessary tunnels and drifts constantly increases. The hydraulic mines of Dutch Flat and Gold Run districts, which may virtually be considered as one district, as the gravel deposit mined is the same in both, are all enjoined from mining. In other sections of the county, where injunctions have been threatened, it was impossible to find acknowledged owners to any of these properties; but this was the only section in 3 counties where hydraulic mining is carried on in which the special agent could get no information. In other hydraulic mining districts of the county full and reliable information was given, and the miners were generally anxious to show the magnitude of their interests which were affected by injunctions from the farming interests of the Sacramento valley.

Regular book accounts are kept only by incorporated companies, except perhaps a blotter or simple record of receipts and expenditures where there are partners, and few books show segregated accounts either for current expenditures or for the investment of capital in plant and mining. With river bed and bar and tailing placers the season is from January to January, other mines from June 30 to June 30. Hydraulic mines are not operated in the summer, and river mines are not operated in the winter.

River bed and bar mining is of such nature that a spot is mined out in one year and a new place taken the next season. These mines are therefore not permanent in character, and all information concerning their operations is open to question.

Concerning the gold product, the larger part is shipped by express to the mint and assay offices in San Francisco. Another large part, including the entire product of some mines, is taken directly to San Francisco and finds its way to the mint and assay offices from first hands or through the banks. The gold product of small surface mines is generally bought by storekeepers and local bankers, also nearly all of the gold taken out of the tailing mines by Chinese, who have a practical monopoly of this kind of mining.

Miners in this county are employed an average of not less than 275 days in the year, and when the season for one kind of mining is ended they are employed in other branches, and in the case of assessment work the same men may work on several claims in the course of a year. In the vicinity of Auburn and Ophir some of the miners are occupied for a considerable part of the year in horticultural pursuits, and only mine when the work in that line is completed, but in other parts of the county the industry is exclusively mining.

### SIERRA COUNTY.

The mines and mining industry of this county may be classified as follows: (1) quartz mines producing gold, distinguished as "milling propositions"; (2) drift placer mines; (3) hydraulic placer mines; (4) quartz mines bearing gold, distinguished as "pocket mines and mining"; (5) river mines of placer gold; (6) surface placer mines in the ravines and gulches; (7) tailing placers, being the reworking of the tailings from the hydraulic mines that are impounded in temporary dams. The order given is that of their relative importance in product, investment of capital, and the number of men employed.

The following is a description of the mines of this county by mining districts:

ALLEGHANY DISTRICT.—Classes 4, 2, and 1 are represented here in relative importance in the order given. Quartz mining for pockets is confined to this district. Quartz veins or lodes as a rule are narrow and irregular, and have their gold contents concentrated into small bunches of quartz of extraordinary richness, while frequently the great mass of vein matter is absolutely barren. Mining is almost entirely through tunnels, requiring no mining plant except car, track, and blacksmith shop to keep picks and drills in order. The gold-bearing quartz when found is panned by hand. The mining is almost exclusively in the hands of working miners, who have but little capital, and as a rule they keep no account of their operations, working intermittently, leaving their own mine to work for wages when they fail to find a pocket and have exhausted their means; but the aggregate results of this class of mining are satisfactory and the industry permanent. Drift placer mining is of steadily decreasing importance, and is confined to 2 producing mines (1 of which is an old mine being worked over for ground missed by the early miners) and to a few prospects that are as yet entirely undeveloped. Quartz mining as a milling proposition does not seem to have been a success, principally from lack of mill quartz. Only 1 mine, the Golden King, a new discovery operating an arrastre, is being worked at the present time, and there is no indication of the opening of other mines.

BRANDY CITY DISTRICT.—The mining industry of this district has been exclusively placer, worked by the hydraulic method, and the 2 mines which comprised all the hydraulic mining ground are now considered worked out. There is a small amount of prospecting going on for drift mines, but no developments as yet.

DOWNIEVILLE DISTRICT.—The town of Downieville is the supply point and most accessible post office for a number of widely scattered mines. The district, if it can be so called, has no distinctive class of mining, all classes except the quartz pocket mines being represented. Probably in annual yield and in the number of men employed drift placer mining is in the lead. It is the center for most of the river bed and bar mining in the county. 1 quartz mine is producing and a number are being prospected. Drift mines and quartz mines are pretty generally in the hands of incorporated companies, or of men with whom mining is not their immediate occupation, consequently fairly accurate and complete records of operations are kept. River mining is entirely in the hands of the Chinese, and but little reliable information can be obtained of their operations. Personal observation and investigation satisfied the agent that there were about 100 Chinese employed in river mining on the North Yuba river, which flows by the town of Downieville, scattered, in about a dozen companies, 10 miles each way from the town. The average time worked each year is 120 days, in 1889 probably 150, and the aggregate product between $35,000 and $45,000 annually. About half of this is sold at the bank of Messrs. Scammon & Co., at Downieville; the other half to a Chinese buyer in the same town or taken direct to San Francisco. The aggregate amount of capital invested by the Chinese in their operations is not more than $25,000. The plant consists of temporary dams in the river, one or more water wheels, and Chinese rotary pumps, derricks, ditches, and sluices to each claim. There is considerable surface placer mining in this district, though comparatively little of it is a regular occupation.

EUREKA NORTH DISTRICT.—The mines of this district are nearly all hydraulic placers, considered worked out, except 2, which are enjoined, and 1 undeveloped drift prospect.

FOREST DISTRICT.—This includes that portion of the county lying between Mountain House, in Sierra county, and Camptonville, in Yuba county, the latter being the usual post-office address. Its mining is almost exclusively confined to small drift mines and shallow placers. The total annual product is comparatively insignificant, and there are no developments being made which indicate any extension of the industry.

FOREST CITY DISTRICT.—This district 10 years ago was the locality of the most extensive and profitable drift mines in the state of California, but all the once rich mines are now practically worked out and most of the mining ground in the district has been prospected, so that there is no probability of new discoveries bringing the district up to its former importance.

**GOODYEARS BAR DISTRICT.**—This district is practically exhausted, only a few shallow placers being worked, with indifferent results.

**GIBSONVILLE DISTRICT.**—This is the leading drift placer mining district of the county, and contains also large areas of unworked hydraulic placers, with excellent water facilities and supplies; but this class of mining at this point has been stopped by injunctions.

The district next to Sierra City seemed to be in a more prosperous condition than any other in the county and to have better prospects for the future in the results of prospecting operations now under way.

**GOLD LAKE DISTRICT.**—This district contains some extremely profitable placers, worked by the hydraulic method, and some promising quartz mines. The placers are shallow and free washing, and very little plant and capital is required for mining. The gold is very coarse.

**PIKE CITY DISTRICT.**—At present there is only 1 operating mine in this district, and its future is not promising. Its importance came from the Alaska quartz mine, a large and at one time very profitable property, but now practically abandoned on account of the immense quantity of water in the deeper workings.

**POKER FLAT DISTRICT.**—The existing mining industry of this district is placer, divided about equally between drift, hydraulic, and surface mining, all of which is carried on in a small way by individual miners and by companies of not more than 6. The mining season is short, confined, except for the drift mines, to not more than 3 or 4 months in the spring, when water from the melting snows can be had. It seems, however, to be the best district in the county for these small operations. The post office of this district is Table Rock.

**PORT WINE DISTRICT.**—At present the importance of this district is dependent on the developments made in 2 drift prospecting operations. There is some unworked hydraulic ground.

**SCALES DISTRICT.**—This is a hydraulic placer district, but the best mines are shut down by injunctions.

**SIERRA CITY DISTRICT.**—The industry of this district is quartz mining for gold, in which it is the leading district of Sierra county and one of the principal districts in the state of California, and will undoubtedly remain so for many years to come. The gold-bearing quartz ledges are large, permanent, with depth, and accessible for mining operations. None of them require any hoisting or pumping plant, being exploited by means of tunnels. The ore is free milling and of fair grade. The mines are operated by incorporated companies, with a large amount of capital invested.

**SAINT LOUIS DISTRICT.**—Formerly a leading hydraulic mining district. It is now becoming equally important by reason of its extensive and profitable drift placers. It is a prosperous mining district, and seems likely to continue so for several years to come.

**TABLE ROCK DISTRICT.**—This is a hydraulic and drift placer mining district. The hydraulic mines are now, however, nearly all worked out, and the future of the district is dependent on the opening of new drift mines, as the old ones, profitable for many years, are nearly exhausted.

Nowhere in the county was any accurate method found for determining the number of tons of quartz mined or milled, the figures given being guesses. Assays are not made except at one or two of the larger mines, and then only for checking the milling losses when suspected. Very seldom is any segregating of accounts made, and accounts for nearly all of the mines, where any are kept, are for the year ended June 30, and not for the calendar year. The expenditures for fitting up hydraulic mines come in the fall of the year, after which they are left until spring, when the snows begin to melt and these claims can be mined; but by early summer the water supply gives out and operations are closed down. Sometimes a few days' run of the mine is had in the fall immediately after the first rains, but the product is not taken out of the sluices.

### YUBA COUNTY.

The mining industry and mines of Yuba county can be classified as follows: (1) drift gravel placer mines; (2) surface placer mines in the ravines and gulches, worked by ground sluicing and sluicing in boxes, occasionally assisted by the use of water under pressure; (3) river mining and the working over of old tailings, confined principally to the North Fork of the Yuba river and followed almost exclusively by Chinese; (4) quartz mining for gold. The order given expresses their relative importance in product.

Drift mining is confined to the old channel deposits of gravel at Smartsville, formerly worked by the hydraulic method. Its results are moderately successful, and have led to the employment of a large number of men in a locality which had been practically abandoned. There is no likelihood of any extension beyond this locality, as there are no other drift gravel deposits in the county.

Surface mining of placer ground is located in Camptonville and Brownsville districts principally. Strawberry valley district is of nearly equal importance. This industry requires practically no capital, except in the few claims where water is used under pressure on low banks of earth in the Brownsville district. It is of constantly decreasing importance as a factor in gold product, as many of the best of the placers are exhausted. Most of this mining is carried on in wet weather, when free water can be had, and the only plant used is a pick and shovel and a string of boxes a foot square in cross-section and from 50 to 100 feet long. Surface miners keep no account of ground washed or mined, either as to area or cubic measurement.

River mining is followed by not over 50 Chinese miners, working in companies of from 4 to 10. More plant is required for this than for surface mining. Derricks for handling large rocks, dams, pumps, and ditches of some permanence, in addition to the pick, shovel, and sluice boxes of the surface miner, are usually required. The claims are more permanent, but do not pay as well per day on the average as the surface mines.

Quartz mining apparently has not been successful in Yuba county, and, except at Brownsville, there is small prospect for this branch of the gold-mining industry.

The large drift mining companies and one or two of the quartz mines keep books. The accounts of 2 of the mines at Smartville have been included in the accounts of mercantile business, which occasions some complication and explains the indefiniteness of the schedules. The other miners as a rule keep no books or permanent memoranda of the time and cost of work, or even of the gold product, usually selling the latter to the storekeepers in small amounts as taken out. In most cases they are utterly unable to give close figures regarding their operations, which are so insignificant and subordinate to other occupations that they should not properly be considered individually, but by the product obtained from parties who purchase it. They do not always sell to the same storekeeper, changing from one to another as their convenience or the difference of a few cents in the price paid per ounce influences them. It is safe to say that 70 per cent of the product of these surface mines worked by whites and Chinese is sold to the storekeepers. About half of the balance goes to the banks at Oroville, in Butte county, and Marysville, in Yuba county, and from them to the San Francisco mint or assay offices. The other half is sent direct by the producers to the mint or assay offices, in order, usually, to ascertain whether the local storekeepers pay a fair price for it. The Chinese who mine the rivers and old tailings are very secretive concerning the product, and are seldom permanent in their occupation of any particular place on the river, or even of the same river from year to year. It is practically impossible to get directly at any details of their operations or product. The best indications are in their mode of living. If their mining is paying they indulge very freely in fresh pork and poultry. From the result of investigations it is believed that about half of their gold product goes to the local storekeepers, and the balance in about equal parts finds its way to the banks at Oroville and Marysville and by express or registered mail to Chinese firms in San Francisco. The storekeepers who buy the gold do not generally consider the product a factor in their business, but generally keep a record showing the date of purchases, names, and amounts. Most of them are also informed of the particular locality whence the gold comes.

In obtaining figures of gold purchased by storekeepers care has been taken to avoid any duplication of product by omitting any amount purchased from individual mines making reports.

The quartz miners do not make fire assays of their ore, but try it in a mill or arrastre. The more pretentious mines may have an assay of the tailings made if they have any reason to suspect a loss in them.

None of the miners pay any attention to the amount of silver in the product. It is all sold as gold.

## COLORADO.

The following report is furnished by Mr. Frederic F. Chisolm, special agent:

Colorado has rapidly advanced to the first place on the list of states as a precious metal producer, and this chiefly by its silver output, which now far exceeds that of any other state and nearly equals that of Nevada when the great Comstock lode was at its best. As a gold producer Colorado ranks next to California and but little ahead of Montana, Nevada, and South Dakota. The precious metal output of Colorado has received great impetus from the rapid extension of the railroad system, and promises to increase to still larger proportions, though the possibilities of Idaho, Montana, New Mexico, Oregon, and South Dakota are perhaps proportionately greater, because they have done so much, especially in silver production, in so short a time and with such inadequate transportation facilities.

During the year under review the mining industries of the state were in a flourishing condition, and the production of gold and silver for the year was the largest in its history. One noteworthy feature of mining in Colorado has been the marked increase in the number of profitable mines worked either by individuals or partnerships, but not under stock organizations. At the same time mining operations have been more under the control of men skilled in practical methods of mining than in the past, and the industry has consequently settled down more to a sound and business-like basis, from which a steady and healthy growth is assured for the future. Another gratifying feature is that the output comes from a very large number of producers, individually of medium or even small prominence, and not from a few large mines operated by corporations and owned outside the state. There are, however, as is well known, examples of phenomenally productive properties; but the fact remains that the bulk of the yield is to be credited to the mines of moderate production, which are owned and worked by citizens of the state. The number of new corporations formed in Colorado in 1889 to operate mines was less than in any year during the past decade. To the act imposing a graded fee (according to the amount of nominal capitalization) for the recording of the incorporation papers of stock companies may be fairly attributed much of the falling off in the mining stock companies incorporated under the state laws.

The extension of the railway systems has had much to do with the progress in mining. There are still many outlying districts which thus far have been handicapped by high freight tolls, but it is hoped and expected that in the near future they will be rendered more accessible. Some of these districts are giving great promise that with the increase of transportation facilities and the resulting decrease in the cost of marketing the ores the growth in the production of the precious metals in Colorado will be marked, and that the progress of this industry will fully keep pace with the great extension of allied interests in the state.

By far the greater portion of the ores of Colorado are reduced by silver-lead smelting in water-jacket furnaces. This is largely due to the remarkable metallurgical skill shown in decreasing the loss in smelting by lowering the percentage of lead required and by the unusual economy with which the process is here carried on. Of late there has been a larger use of calcining and reverberatory furnaces for the preliminary treatment of refractory ores to be smelted. The ores are not reduced at the mines, but are shipped either as crude run of mine or are concentrated at the point of production and the concentrates sent to the custom smelting works. Even where the ores are "dry" (that is, containing a low percentage of lead, or none) they are usually shipped to the smelters for mixture with other ores, with better metallurgical and commercial results than if they were treated by the amalgamation or lixiviation processes. This practice of shipping and selling ores or concentrates instead of working them on the spot is due to the almost invariable lack of success following all attempts to operate silver-lead furnaces on the ores of single mines or districts; also to the habit of selling the ores through public sampling works, which practically conduct a commission and brokerage business by correctly ascertaining the value of the shipments and selling the lots to the highest bidder. This system has been especially advantageous to the smaller mines, as it obviates the cost of erecting reduction works and affords immediate cash returns for the product. A number of large and well-equipped smelting plants have been established in Colorado, the principal centers being at Denver, Durango, Leadville, and Pueblo. These works buy ores from all quarters and draw also upon districts outside the state. By the preliminary admixture in beds of various ores in order to secure as nearly as possible a typical smelting ore they are enabled to operate to the best advantage and handle large quantities of ores which could not be profitably treated by themselves.

Silver amalgamating mills and leaching works are not in vogue in Colorado, where the conditions, as just stated, are more favorable to the smelting process. There are, however, a number of amalgamating mills for working free-gold ores. The treatment of such ores by crushing, either by stamps, rolls, or centrifugal mills, is carried on to a large extent in Gilpin county, where the ores are practically all auriferous sulphides, in which the uncombined gold readily amalgamates. Battery amalgamation is relied on to a larger degree than is customary in other districts.

Concentration of the smelting ores before shipment is becoming more general, a large number of custom concentrating plants being now in successful operation. These enable large quantities of low-grade ores to be utilized, which in the crude state could not meet the expense of transportation. The desirability of the sulphides of iron and of iron and copper in the process of calcining in reverberatory matte furnaces has led to a great increase in concentration, after amalgamation, of the pyritous ores, especially of Gilpin county.

Placer mining in Colorado, as elsewhere in the United States, is decreasing, and more attention is being paid to lode deposits. In this state, indeed, placer mining has never been of very great importance since the remarkable success in lode mining. There are, however, many small placers, some of them rich, which will continue to yield their quota for years to come. There are also some placer deposits which have not yet been worked for want of water. These latter may be brought into operation in the future.

Only a small portion of the base bullion produced by the silver-lead furnaces is refined in Colorado, although a great part of the bullion shipments goes to a refinery which is practically a branch of one of the largest Colorado smelting works.

The leading counties in point of production of gold and silver are Lake (in which is the Leadville district), Pitkin (containing the Aspen and other flourishing districts), and Clear Creek. Gilpin, Ouray, Summit, San Juan, and San Miguel counties also contribute largely. The list of counties which produce more or less gold and silver is a a long one, and besides the productive counties there are others which have not yet been thoroughly prospected, and which in time will probably be added to the number. Briefly, the condition of precious metal mining in Colorado during 1889, in the several counties which take rank as distinctively mining regions, is indicated in the following notes:

### BOULDER COUNTY.

This county contains what is practically the northernmost end of the mineral belt, though there are a few outlying districts of minor importance still farther north. The ore is principally free-milling and sulphuret gold quartz, which is treated by local mills, which extract the free gold and concentrate the auriferous sulphurets, the concentrates being sent to the smelters. There is also some silver smelting ore produced, which is shipped to one of the large smelting establishments in the state, as there are no smelters in the county. A very little placer mining is being done.

### CHAFFEE COUNTY.

There is considerable placer mining (on a small scale individually) along the Arkansas river, but the main reliance of the county is on lode mining. The ores are of 2 classes—free-gold quartz (of which the production is comparatively small) and smelting ores. These latter are shipped principally to Leadville, Denver, and Pueblo.

### CLEAR CREEK COUNTY.

This is the third in point of production of the gold and silver mining counties of Colorado, its output being $3,000,000 and upward annually. The ores are mainly silver-lead smelting ores. Most of the camps are of long standing, but the Ute district entered on a large production for the first time in 1889. There is but little placer mining in the county.

### CONEJOS COUNTY.

Active operations were resumed in 1889 in several of the old districts, in which nothing had been done for years, making Conejos practically a new mining field.

### COSTILLA COUNTY.

The mining territory in this county is mostly held under the Costilla land grant. An insignificant amount of work is being done in the neighborhood of Culebra.

### CUSTER COUNTY.

This is an old mining region. There were no important new developments during the year. Mining is confined to the lode deposits, which yield smelting ores, all of which, ore and concentrates, are shipped out of the county for treatment.

### DOLORES COUNTY.

A little placer mining is being done on Disappointment creek. The principal lode mines are at Rico. They produce silver-lead smelting ores, all of which are shipped to outside reduction works.

### EAGLE COUNTY.

This county contains silver-lead ores in a limestone formation very similar to that of Leadville, Lake county. There are also peculiar gold ores occurring in caves in quartzite. Both kinds of ore are shipped out of the county for treatment.

### FREMONT COUNTY.

This county has not yet attained prominence as a precious metal producer. Mining is confined to lode deposits, which are worked on a small scale.

### GARFIELD COUNTY.

There was practically no mining in this county in 1889. The results of operations in the past have not been sufficiently encouraging to lead to a thorough prospecting of the region, so that its capabilities remain to be determined.

### GILPIN COUNTY.

The oldest mining camps of Colorado are found in Gilpin county, and productions still continue to be steady and reliable. The ores are principally free-milling gold quartz, which are treated in local mills, and after amalgamation are concentrated, the concentrates (auriferous sulphurets) being sold to the smelters. Much placer mining is carried on in the county. There is also a small output of silver-lead smelting ore, which is shipped. Large operations are prosecuted at Bald Mountain, Black Hawk, Central City, Nevada, Rollinsville, and Russell.

### GUNNISON COUNTY.

This county covers a large area and contains many mineral deposits. There is a little placer mining near Tin Cup, but the principal operations are on the lodes. The ore is generally found in fissure veins, except at Tomichi and White river, where silver-lead deposits are met. An interesting development of gold ores at Tin Cup was made during the year 1889.

### HINSDALE COUNTY.

Mining in Hinsdale county was greatly retarded in former years by insufficiency of transportation facilities. In 1889, however, a branch of the Denver and Rio Grande system was extended into the county. The mines, which are all on lode deposits, ship their products out of the county for reduction.

### HUERFANO COUNTY.

Mining is carried on to a slight extent in the neighborhood of Gardner, Malachite, and Sharpsdale. The output is small. There are some placers in the county, which, however, are not at present worked.

### LAKE COUNTY.

Lake county contains the famous Leadville district, which has been so often described as to make its character generally known. The ores are of the silver-lead smelting class, occurring on contacts of limestone with the overlying porphyry. During the year some very interesting developments were made immediately under the town of Leadville. It has been proved that the great ore bodies extend much farther than was formerly believed. These explorations have resulted in heavy shipments from the new ore-bearing territory in 1890. While the average grade of the Leadville ores is lower than formerly and the annual aggregate output in bullion is less, the ore tonnage was greater in 1889 than at any previous time in the history of the district. Toward the close of 1889 work was resumed in the old Homestake district.

### LA PLATA COUNTY.

This county contains several mining camps, though the output thus far is not large. The deposits are believed to be of great value, but the country is extremely inaccessible. Mining is confined to the lodes. The ores are refractory, and are mostly smelted at Durango, in the county.

### LARIMER COUNTY.

There are a number of promising gold properties at Manhattan, but owing to the inaccessibility of the region the output in 1889 was small.

### OURAY COUNTY.

Ouray county is an important source of the precious metals. The ore occurs in fissure veins traversing various eruptive rocks. It is all shipped out of the county, either as crude ore or as concentrates. Mining is confined to lodes. The leading districts are Ouray and Red Mountain. At the latter place there was greatly increased activity in 1889, and, indeed, throughout the county great progress is being made.

### PARK COUNTY.

This county is one of the oldest mining regions in the state, and contains both lode and placer mines. The latter are of considerable value, but were not largely worked in 1889. No new developments of importance were made during the year.

### PITKIN COUNTY.

Pitkin county is the second largest producing county in Colorado, and furnished a largely increased output in 1889. The ores are smelted and are generally "dry", although an unusually large proportion of the ore mined in that year carried lead in notable quantity. The principal camp is Aspen. Ashcroft district contains promising deposits, but has suffered from need of transportation facilities, and developments there are waiting for railroad connections to be made. A marked increase in mining and in production occurred in Tourtelotte Park in 1889, and very flattering developments have been made on Maroon creek, as well as on Frying Pan, Hunter, and Woody creeks. In these last 3 localities explorations seem to indicate that the ore-bearing contact of Aspen has been found.

### RIO GRANDE COUNTY.

The operations in this county are confined to lode mining. There was a comparatively small production in 1889, owing to various causes. A considerable proportion of the ore is free-milling gold quartz; the remainder is smelting ore, which is sold and shipped away for reduction.

### ROUTT COUNTY.

A small output of gold came from the Hahns Peak placers in 1889. In the same region there are also a number of promising free-gold lode claims.

### SAGUACHE COUNTY.

This county is extremely inaccessible, and for this reason mining operations have heretofore been on a small scale. The lodes only are worked. The ore is of the smelting class, but is very refractory.

### SAN JUAN COUNTY.

San Juan county is one of the important producers, containing a number of free-gold mines, which were worked on a large scale during the year. There are also important deposits of mixed sulphide smelting ores in fissure veins. Mining is confined to the lodes.

### SAN MIGUEL COUNTY.

Both placer and lode mining is carried on in this county. The Marshall Basin mines (smelting ores) produced largely during the year, and renewed activity was manifested at Ophir, one of the oldest camps in the state. All of the smelting ores are shipped out of the county.

### SUMMIT COUNTY.

Summit county also is a large producer, containing a very large number of mines, both lodes and placers, but the greater part of the output comes from the many small mines of silver-lead ores. Mining has been carried on in this county without much change for many years, Summit being one of the first mining counties in the state to be opened.

## CONNECTICUT.

New England does not appear as a factor in the production of either gold or silver in the year 1889, and only one state, Connecticut, shows any operation. In Hartford county a considerable amount of work was done in the way of redeveloping an abandoned mine. In the prosecution of this work expenses to the amount of $17,738 were incurred, as follows:

DISTRIBUTION OF EXPENDITURES IN GOLD MINING IN CONNECTICUT.

| | |
|---|---|
| Paid for wages | $10,036 |
| Paid for supplies | 3,977 |
| Other expenditures | 3,725 |
| Total | 17,738 |

## NEW MEXICO.

The following is an abstract of a report made to the United States mint by Mr. Walter C. Hadley:

New Mexico has been but slightly explored by prospectors for the precious metals. Practically only 1 railroad penetrates those portions where gold, silver, lead, or copper has been found in marketable quantities, and only 2 other railroads traverse sections where ores of value may be expected. One of the latter transported last year but 65 tons of ore from points within the territory, and the other carried ores from only 2 shipping points in New Mexico, and those in very inconsiderable amounts. In other words, it may be said that 1 railroad carried all the ores and bullion produced by the territory, and of its total mileage within the territory about 11 per cent is in short branches from the main line, which have been constructed to facilitate ore shipments. Many promising discoveries have been made at points where active operations may be expected when railroad facilities reach them. Only a general review of the production by counties is given.

### COLFAX COUNTY.

The output of gold for a number of years from the placers and quartz ledges of Colfax county, particularly of the Ute Creek and Elizabethtown districts, has been considerable, and in some years quite large.

### DONNA ANA COUNTY.

The Organ mountains chiefly furnished the precious metals produced in this county in 1889, the silver-lead mines being the ones most actively worked. The gold output was unimportant. There are no local works for the treatment of ores, which are hauled to Las Cruces for railroad transportation.

### GRANT COUNTY.

The first discovery of the precious metals in Grant county was made in May, 1860, when gold was found in both gravel and ledge at Pinos Altos. 10 years later silver mines near Silver City began to be worked, and for 25 years the county has been more reliable and constant in production than any other in New Mexico. Sierra county has in certain years surpassed it, but development work there has neither been so widely extended nor so unremittingly prosecuted. In both counties it is noticeable that the most valuable silver mines are in contact veins, with lime for one wall and either lime, slate, or porphyry for the other. It is also noticeable that the best gold veins are fissures, chiefly in syenite. There are a few silver-lead fissure veins of great promise. The ore is free-milling, and all the lower grades are treated by amalgamation at the local mills. Pinos Altos led as a gold producer. The principal mines have also their own mills, wherein the ores are treated by amalgamation and concentration. The concentrates are shipped to smelters in Socorro, New Mexico, or Denver, Colorado. As yet a high percentage of saving has not been attained by some of the mill men.

Many engaged in the mining of the precious metals are incapable of correctly estimating the cost of producing a ton of ore. Those who have had only limited experience rarely place the cost at more than $4. Of course, large bodies of low-grade gold ores and lead carbonate ores may be found that can be mined at this or a much lower figure. Miners of more extended experience, however, put the cost of mining from the average vein at from $15 to $25 per ton. It is believed, however, that the average cost is not much more nor less than $30 per ton for every ton of ore mined in New Mexico, and the mines of New Mexico are not different from those of Colorado or Montana.

### LINCOLN COUNTY.

Since 1879 gold has been produced in White Oaks, and discoveries of gold in other parts of the county have been made. A large amount of money was squandered by eastern operators, who undertook to introduce novel methods. Within the past 2 or 3 years experienced miners and mill men have taken hold of the White Oak mines and attained success.

### SANTA FE COUNTY.

Recent discoveries of silver-bearing lead carbonates near San Pedro are important. During 1889 the output therefrom was about 4,000 tons, containing gold, $6,520; lead, $52,430, and silver $77,310. More than three-fourths of this amount was taken from the Lincoln Lucky mine.

### SIERRA COUNTY.

The only rival Sierra county has in the production of the precious metals is Grant county. The mines of the latter, however, were productive for many years before those of Sierra were discovered. There is a larger proportion of mountainous country in Sierra than in any other county in New Mexico, and mining is the chief occupation of its people. At Lake Valley there is a leaching mill and an amalgamating mill, with joint capacity of 100 tons per day. Neither is in operation. All ore is shipped, as it is in demand with smelters for fluxing purposes. A 20-stamp gold mill is in operation at Hillsboro. Hermosa has a concentrator, Chloride a leaching mill, and Kingston a concentrator. Other producing districts are Animas, Chloride, North Percha, South Percha, and Tierra Blanca.

### SOCORRO COUNTY.

During the year Socorro county became prominent as a gold producer. The new discoveries were in the Mogollon mountains, where 2 stamp mills have been in operation, one at Cooney and the other on Silver creek. The prospects for increased production in this section are promising. Other producing camps furnished chiefly silver-lead ores of excellent fluxing qualities, which have made Socorro a smelting center. A new smelter was erected at Kelly Camp last winter, but it is not yet in operation.

SMELTING WORKS.—The only custom smelting works in practical operation in New Mexico during the year 1889 were those of the Rio Grande Smelting Company, at Socorro. The product, as base bullion, was shipped to the Saint Louis Smelting and Refining Company. Arizona, Mexico, and New Mexico furnished almost all of the ores treated. There are in the territory smelters at Albuquerque, Carlisle, Deming, Kelly, Kingston, Las Cruces, Silver City, and Socorro, all of them idle.

## WYOMING.

The following report is furnished by Mr. John W. Burkhardt, special agent:

The Miners Delight mines, in the Sweetwater country, Fremont county, consist of 5 mines, but only 2 have been developed. This group of mines, as well as those in Atlantic City and South Pass, all lie in a hard blue porphyritic slate in veins from 16 inches to 8 feet wide, with a greenish wall on each side. The quartz is sometimes bluish, again it is feldspathic, with free gold disseminated through it and plainly visible to the naked eye; but most of these leads also contain zinc, antimony, tellurium, arsenical iron, traces of tin, etc., which consequently make the ore in general refractory. Atlantic City, Miners Delight, and South Pass are only 4 miles distant from each other, and all the mines are in the foothills nearest the prairie. The main range, where the best mines ought to be situated, has not as yet been prospected. The foothill mines have been very rich pocket mines; in fact, several thousand dollars were pounded out in hand mortars.

Miners Delight has 3 quartz mills of the pattern of 1858. These were in operation only a short time, and the principal reason that these mines were abandoned at so early a stage of their development was the reckless waste of large sums of money. The capitalists who furnished the money, being disinclined to come out to what was then a wild country infested with hostile Indians, left the whole management of the mines to persons whom they employed. The investors, receiving no returns, presumed that the mines were valueless, and therefore had them closed down; and there is not up to this date a shaft 200 feet deep either at Atlantic City, Miners Delight, or South Pass. The ore of most of the mines assays in bulk from $9.50 to $180, and will average, with moderate concentration, from $6 to $14 per ton throughout the camp. All machinery could be driven by water power, but the mines lie in the foothills. As it now stands, it is merely a rich specimen country. Recently two boys discovered a lead about 500 feet south from the old Buckeye lode, with ore assaying from $23 to $40 per ton. The vein is about 20 inches wide, and the rich quartz came out of a pocket in it. These mines, and, strange to say, every mining district of any note in Wyoming, are situated on the southeast side of the mountains. There are 2 districts, about 12 miles apart, the Seminoe and the Ferris. Seminoe, the most southern mountain, nearest to the Platte river, lies about 40 miles north of Rawlins, and has free-gold bearing veins, and formerly had a 10-stamp mill running, but as fuel was scarce and the mine in litigation it was closed down, although development work is still going on. In the Ferris district the leads are principally silver-bearing low-grade galena, oxide of iron, and sulphide of iron.

## NONPRODUCING STATES.

Letters were sent to the state geologists or other officials in the states not included in the list of states and territories producing the precious metals, with a view of learning, if possible, whether any recent discoveries of gold and silver had been made in these states in recent years. The following are abstracts from the replies received:

### MAINE.

Gold is reported to have been found in the sand of a stream called Sandy river, in the northern part of Franklin county. A stock company has been organized to mine it, but no statistics of production have been obtained.

### VERMONT.

The state geologist says that no mines of gold and silver are being worked in the state at present.

### NEW JERSEY.

The state geologist states that he knows of no gold or silver mines in the state.

### TENNESSEE.

The state geologist reports that he doubts very much whether any silver has been produced in the state during the last year, or, for that matter, at any time in the past. In former years, and especially before the war, some gold was obtained at points in Tennessee adjoining the North Carolina line. A little gold is found in Blount, Cocke, Monroe, and Polk counties.

### FLORIDA.

The commissioner of agriculture writes that there are no deposits of gold or silver known to exist in this state. Some "finds" have been reported in Marion county, but he can not vouch for the truth of the reports.

### KENTUCKY.

The assistant in charge of the geological survey reports that there are no mines of either gold or silver in Kentucky.

### ILLINOIS.

The state geologist says no gold or silver is produced in the state, although both metals are known to exist in the lead ores of Hardin county and have also been found occasionally in the drift gravels of other counties.

### MINNESOTA.

The state geologist reports that there is no gold or silver mining within the state of Minnesota.

### MISSOURI.

The state geologist reports that several mines have been opened in the state in search of gold and silver, but have, for the most part, been abandoned. None of the mines have ever paid expenses, though some of them contain fine silver ore in very small amounts. Besides these there are many worthless gold mines, in which more or less money has been spent.

## THE INFLUENCES WHICH AFFECT THE PRODUCTION AND RELATIVE VALUES OF GOLD AND SILVER.

Gold, being coined free, is independent of market quotations, and its output depends solely upon the cost of production, where not restricted by legal enactment, as is now the case in California. In periods of mining excitement, or "booms", induced generally by the discovery of exceptionally rich deposits, the investment of capital in developing mines and in working unprofitable properties adds somewhat to the normal output, but since the greater part of the gold is now produced from regular, as opposed to intermittent, mining enterprises, the effect of booms on the production of the precious metals is not very marked. Their chief influence is felt at a later period, for a mining excitement generally results in the discovery of some mines that later on become regular and profitable producers. The discovery of the rich placer deposits of California in 1848 quickly increased the gold product from insignificant proportions to $50,000,000 in 1850, $60,000,000 in 1852, and to the highest figure it has ever reached, namely, $65,000,000, in 1853. Placer gold, even where found over such an enormous area as in California, is worked out in a comparatively short time, and the statistics quoted in this report show that the gold production rapidly declined after 1853, notwithstanding the vast number of people attracted to mining by the fabulous profits earned by the few fortunate ones. In 1862 the product had declined to $39,200,000, but the discovery of other washings, and particularly of the great Comstock lode in Nevada shortly after that, began to be felt. This district in 1862 produced $2,500,000 of gold and silver, and has since added so enormously to the precious metal supplies that it sustained the gold product, notwithstanding the heavy decline in the output of the hydraulic mines of California. The Comstock district continued to increase until 1876, when it reached its maximum of $38,000,000 in one year, of which about $16,000,000 was gold and $22,000,000 silver. In all, since 1860, this great deposit has produced no less than $320,000,000, of which about $125,000,000 was gold and $195,000,000 silver. Notwithstanding this enormous addition to the gold product, the total annual gold yield of this country has declined since 1853, though it recovered somewhat its lost ground in the years 1865 to 1870, when it reached again above the $50,000,000 mark. Since then it has gone as low as $30,000,000, in 1883, and has since then increased but very little.

The chief reasons for this decline in the production are to be found in the working out of the auriferous gravel deposits in various parts of the country, and in California legislation, which since 1882 has practically prohibited hydraulic mining and has been the chief cause in bringing the output of that state down from $17,000,000 in 1882 to $12,586,722 in 1889. The decline in the Comstock has already been referred to as the cause of a heavy decline in the Nevada gold product from more than $19,000,000 in 1878 to about $3,500,000 a year at the present time. Most of the states which are small or moderate producers are increasing slightly and steadily, but this is far from compensating for the heavy losses in California and Nevada.

Whether the production of gold in the future will increase or diminish is a very important question, which a mere study of these statistics of the metal can not solve. It is certain that the repeal of the antidébris legislation in California would add very largely to the gold output of that state, but aside from this there is no apparent prospect of any rapid increase in gold production. It is of course possible that some new auriferous gravel deposits may be found or worked and that some great gold-bearing bonanza, like the Comstock, may be discovered, but so far as present knowledge goes the gold production of the future will come in constantly increasing proportion from the treatment of gold-bearing ores and less and less from gravel mines; in other words, gold production in the future will be more and more from permanent and but slightly-fluctuating sources and less and less from great "finds". Whether the certain but rather slow growth of the output from the treatment of ores will more than compensate for the equally certain gradual lessening quantity produced from placers can not, of course, be foretold, but the fact that the production of gold in recent years has not only ceased to decline, but has even increased slightly, seems to indicate that this country will be at least able to maintain and will probably gradually increase the output of this indispensable metal.

The immense progress made in metallurgy in recent years has permitted the extraction of the gold from many ores which were formerly of too low grade to pay for treatment. Unquestionably this progress will continue and in time very important amounts will be added to the yearly output.

The production of gold and silver in the United States is coming more and more from the treatment of the gold-bearing ores of other metals and less from strictly gold and silver ores. The industry is becoming year by year more of a regular nonspeculative manufacturing business, in which great "finds" and bonanzas have less and less influence, and it is therefore certain to increase with a steady and healthy growth. Investments in precious metal mines still continue to be made as "gambles", and consequently are still, on the whole, unprofitable; but every year diminishes this unhealthy characteristic of mining, and brings the industry more into the category of legitimate industrial enterprises, where investments are made with the same precautions as in other classes of business, and moderate profits are sought as the reward of steady industry, while the class of "millionaires of a day" is disappearing. At the present time about 134,000 tons, or 72 per cent, of the entire output of lead is silver-bearing or silver and gold bearing, and is "desilverized" before marketing, while nearly all the copper produced in Montana, amounting in 1889 to about 100,000,000 pounds, and nearly all that mined in California, Colorado, Nevada, Utah, and other western states, except in some of the Arizona copper mines, carries silver and gold. It has not been possible to ascertain exactly the amount of gold and silver that has come from the treatment (for the most part the smelting) of copper and of lead ores.

The progress in metallurgy is, however, adding still more rapidly to the production of silver than to that of gold; so that while the output of gold will probably increase in the future, that of silver, a much more abundant metal in nature, will undoubtedly increase still more rapidly. Nearly every improvement which tends to reduce the cost of production, whether it be an improvement in metallurgical processes, which enables the extraction of a larger proportion of the metal from its ores or to extract it at less cost, whether it be the building of railroads, which reduces the cost of transportation of the machinery and supplies used at the mines and with these reduces the cost of labor, nearly everything, in fact, that tends to make gold more abundant, increases in a still greater degree the production of silver. Hence it is evident that the relative value of gold as compared with silver will continue to increase unless free coinage is given to both metals and some international agreement is established fixing the relative value of the metals independent of their abundance.

The following table gives the proportions by weight and by United States coining values (16 to 1) at which the two metals have been produced in the United States and in the whole world since 1850. Further discussion of the the world's statistics will be found on the following page.

PROPORTIONS IN WHICH GOLD AND SILVER HAVE BEEN PRODUCED.

| YEARS. | UNITED STATES. | | | THE WORLD. | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | By weight. | | | By weight. | | | By United States coining value. | | |
| | *Gold.* | | *Silver.* | *Gold.* | | *Silver.* | *Gold.* | | *Silver.* |
| 1850 | 1 | to | 0.016 | 1 | to | 16.00 | 1 | to | $1.000 |
| 1860 | 1 | to | 0.032 | 1 | to | 5.47 | 1 | to | 0.345 |
| 1870 | 1 | to | 5.120 | 1 | to | 5.79 | 1 | to | 0.485 |
| 1880 | 1 | to | 17.440 | 1 | to | 14.20 | 1 | to | 0.890 |
| 1889 | 1 | to | 32.320 | 1 | to | 21.92 | 1 | to | 1.370 |

The chief influences which in the future will affect the production of the precious metals, and which will always be more potent in increasing that of silver than that of gold, are improvements in metallurgical processes which will permit of extracting the metals from lower and lower grade ores. It is safe to assume that ores will always be worked down to the limit where the market value of the metal produced ceases to pay for its extraction. Fluctuations in the market value are rather the consequences than the causes of fluctuations in the amount produced.

### COST OF PRODUCING GOLD AND SILVER.

The actual cost of production of the precious metals varies so greatly at different mines and works that it would be impossible to arrive at any absolutely accurate average. That one of the great gold or silver mines, when in bonanza, earns enormous profits merely means that the cost of production is but a small part of the market value of the metal produced. But the mirage of the widely known, if not long, list of millions accumulated by fortunate owners of gold and silver bonanzas induces the investment of millions in the opening and working of prospective bonanzas that never materialize, and encourages and supports the lonely prospector in his wearisome waiting for the fortune that never comes. The spirit of the gambler controls in great measure investments in precious metal mines, and so far as this class of investment goes there can be no doubt that it is, on the whole, unprofitable, or, in other words, that the gold and silver obtained by it cost much more than they are worth in the market.

When the enormous amounts of money actually invested in unprofitable mines and mills are considered, some of which are strictly legitimate and honest, while some have been "salted" or sold on false representations, it is easy to recognize the heavy offset to the great profits of the few large producers and to believe that the average cost of all the gold produced is more than $20.67 per ounce troy, and that of silver is more than, say, $1 per troy ounce. In gold and silver mining, as in buying lottery tickets or in playing on the gaming table, it is the chance of winning a prize that induces people to put their money into what is, on the average, an unprofitable investment. Moreover, the money invested in mining comes back to some of the investors or to the promoters and inducers of investment in many other forms, such as through the furnishing, at large profit, of supplies to the miners, or in the advance in the value of property in the vicinity, or in building up a town, or in some other way that can not be directly credited to the mine. Thus it is that while gold and silver mining on the whole may have been unprofitable to those who have without proper and reasonable precautions invested capital in them, there can be no question whatever that this great industry has been enormously advantageous to the country at large. It has created in the western states and territories a vast empire, has developed many other industries, and brought unexampled prosperity and a vast population. The industry deserves and should receive every consideration which the laws of the country can afford. Nor is gold and silver mining on the average necessarily unprofitable. With the exercise of ordinary care and prudence gold and silver mining becomes one of the most profitable industries in which capital can invest; but unfortunately a majority of those who invest in it do so, as they make bets on horse races, without any knowledge to justify the investment.

## THE WORLD'S PRODUCTION OF GOLD AND SILVER.

In order to appreciate the importance of the gold and silver production of the United States it is necessary to make comparison with that of the world, and to do this intelligently it is imperative to investigate the differing statistics of the world's production and to deduce from all the data available the most probable figures. The accompanying diagrams, showing the production and relative values of the two metals and the study of the decline in the price of silver, will greatly assist in comprehending this subject.

The accompanying table, credited to Dr. Adolph Soetbeer's "Materials toward the elucidation of the economic conditions affecting the precious metals", is taken from the report of the British commission on recent changes in the relative value of the precious metals (1887). The accompanying diagram has been made by plotting the figures in the table representing values.

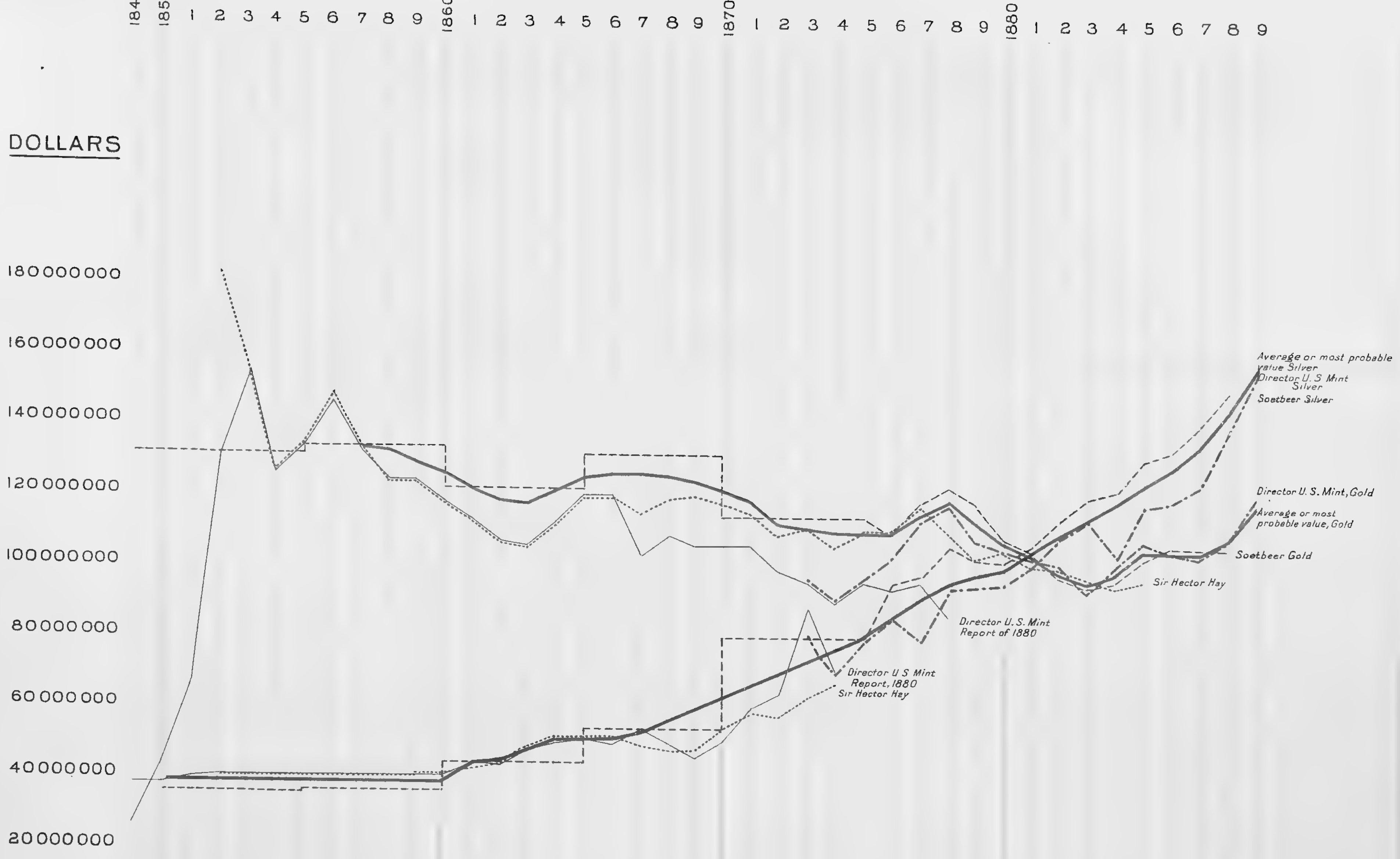
SOETBEER'S ESTIMATES OF THE PRODUCTION OF THE PRECIOUS METALS FROM 1493 TO 1885.

| PERIODS (ANNUAL AVERAGE). | WEIGHT. | | | | VALUE. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Gold. (Kilograms.) | Silver. (Kilograms.) | Percentage of proportion. | | Gold. (Thousands of marks.) | Silver. (Thousands of marks.) | Percentage of proportion. | | Gold and silver. (Thousands of marks.) | Value in gold of 1 kilogram of silver. (Marks.) |
| | | | Gold. | Silver. | | | Gold. | Silver. | | |
| 1493-1520 | 5, 800 | 47, 000 | 11. 0 | 89. 0 | 16, 182 | 12, 220 | 57. 0 | 43. 0 | 28, 402 | 260 |
| 1521-1544 | 7, 160 | 90, 200 | 7. 4 | 92. 6 | 19, 976 | 22, 370 | 47. 2 | 52. 8 | 42, 346 | 248 |
| 1545-1560 | 8, 510 | 311, 600 | 2. 7 | 97. 3 | 23, 742 | 76, 965 | 23. 6 | 76. 4 | 100, 707 | 247 |
| 1561-1580 | 6, 840 | 299, 500 | 2. 2 | 97. 8 | 19, 083 | 72, 779 | 20. 8 | 79. 2 | 91, 862 | 243 |
| 1581-1600 | 7, 380 | 418, 900 | 1. 7 | 98. 3 | 20, 590 | 98, 860 | 17. 2 | 82. 8 | 119, 450 | 236 |
| 1601-1620 | 8, 520 | 422, 900 | 2. 0 | 98. 0 | 23, 771 | 96, 421 | 19. 8 | 80. 2 | 120, 192 | 228 |
| 1621-1640 | 8, 300 | 393, 600 | 2. 1 | 97. 9 | 23, 157 | 78, 326 | 22. 8 | 77. 2 | 101, 483 | 199 |
| 1641-1660 | 8, 770 | 366, 300 | 2. 3 | 97. 7 | 24, 468 | 70, 330 | 25. 8 | 74. 2 | 94, 798 | 192 |
| 1661-1680 | 9, 260 | 337, 000 | 2. 7 | 97. 3 | 25, 835 | 62, 682 | 29. 2 | 70. 8 | 88, 517 | 186 |
| 1681-1700 | 10, 765 | 341, 900 | 3. 1 | 96. 9 | 30, 034 | 63, 593 | 32. 1 | 67. 9 | 93, 627 | 186 |
| 1701-1720 | 12, 820 | 355, 600 | 3. 5 | 96. 5 | 35, 768 | 65, 075 | 35. 5 | 64. 5 | 100, 843 | 183 |
| 1721-1740 | 19, 080 | 431, 200 | 4. 2 | 95. 8 | 53, 233 | 79, 772 | 40. 0 | 60. 0 | 133, 005 | 185 |
| 1741-1760 | 24, 610 | 533, 145 | 4. 4 | 95. 6 | 68, 662 | 100, 764 | 40. 5 | 59. 5 | 169, 426 | 189 |
| 1761-1780 | 20, 705 | 652, 740 | 3. 1 | 96. 9 | 57, 767 | 124, 021 | 31. 8 | 68. 2 | 181, 788 | 190 |
| 1781-1800 | 17, 790 | 879, 060 | 2. 0 | 98. 0 | 49, 634 | 162, 626 | 23. 4 | 76. 6 | 212, 260 | 185 |
| 1801-1810 | 17, 778 | 894, 150 | 1. 9 | 98. 1 | 49, 600 | 160, 053 | 23. 7 | 76. 3 | 209, 653 | 179 |
| 1811-1820 | 11, 445 | 540, 770 | 2. 1 | 97. 9 | 31, 932 | 97, 339 | 24. 7 | 75. 3 | 129, 271 | 180 |
| 1821-1830 | 14, 216 | 460, 560 | 3. 0 | 97. 0 | 39, 663 | 81, 519 | 32. 7 | 67. 3 | 121, 182 | 177 |
| 1831-1840 | 20, 289 | 596, 450 | 3. 3 | 96. 7 | 56, 606 | 105, 572 | 34. 9 | 65. 1 | 162, 178 | 177 |
| 1841-1850 | 54, 759 | 780, 415 | 6. 6 | 93. 4 | 152, 777 | 137, 353 | 52. 7 | 47. 3 | 290, 130 | 176 |
| 1851-1855 | 199, 388 | 886, 115 | 18. 4 | 81. 6 | 556, 308 | 160, 387 | 77. 6 | 22. 4 | 716, 695 | 181 |
| 1856-1860 | 201, 750 | 904, 990 | 18. 2 | 81. 8 | 562, 899 | 164, 709 | 77. 4 | 22. 6 | 727, 608 | 182 |
| 1861-1865 | 185, 057 | 1, 101, 150 | 14. 4 | 85. 6 | 516, 326 | 199, 308 | 72. 1 | 27. 9 | 715, 634 | 181 |
| 1866-1870 | 195, 026 | 1, 339, 085 | 12. 7 | 87. 3 | 544, 139 | 239, 696 | 69. 4 | 30. 6 | 783, 835 | 179 |
| 1871-1875 | 173, 904 | 1, 969, 425 | 8. 1 | 91. 9 | 485, 207 | 344, 649 | 58. 5 | 41. 5 | 829, 856 | 175 |
| 1876-1880 | 172, 414 | 2, 450, 252 | 6. 6 | 93. 4 | 481, 045 | 382, 062 | 55. 7 | 44. 3 | 863, 107 | 156 |
| 1881-1885 | 149, 137 | 2, 861, 709 | 5. 0 | 95. 0 | 416, 098 | 428, 760 | 49. 3 | 50. 7 | 844, 858 | 150 |

Referring to the table and the diagram, it is seen that between 1493 and 1660 the production of gold was nearly stationary. The value of the silver product increased about eightfold between 1493 and 1600, and the price of silver decreased from 260 marks per kilogram to 236 marks. During the next 60 years the silver product decreased: but the price of silver, instead of increasing, decreased much more rapidly than in the earlier period.

From 1660 to 1780 the production of silver greatly increased, then rapidly decreased to 1820, and again greatly increased to 1860. The gold product increased from 1660 to 1760, decreased to 1820, and then increased more than tenfold between 1820 and 1860. The relative value of the total production of gold and silver varied through wide ranges from 1660 to 1860. Notwithstanding these violent fluctuations in both metals, and in the relative product of each, the price of silver per kilogram remained nearly stationary during these 200 years. From 1860 to 1885 the production of gold decreased and that of silver increased, but the great decline in price of silver did not set in till 1873.

The table following shows the world's production of gold and silver from 1849 to 1889, as given by different authorities. The figures in the columns headed "Soetbeer", from 1851 to 1884, inclusive, are from Dr. Adolph Soetbeer's "Materials toward the elucidation of the economic conditions affecting the precious metals", second edition, Berlin, 1886, translated by Professor F. W. Taussig, and published in Mr. Edward Atkinson's report of bimetallism in Europe, 1887. (Executive document 34, Senate, Fiftieth Congress, first session.)



WORLD'S PRODUCT OF GOLD AND SILVER FROM 1849 TO 1889

WORLD'S PRODUCTION OF GOLD AND SILVER.

| YEARS | GOLD. (Millions of dollars.) | | | | SILVER. (Millions of dollars.) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Soetbeer. | Sir Hector Hay. | Mint report, 1880. | Mint report, 1889. | Soetbeer. (a) | Sir Hector Hay. | Mint report, 1880. | Mint report, 1889. | |
| | | | | | | | | Commercial value. | United States coining value. |
| 1849 | | | 27.1 | | | | 39.0 | | |
| 1850 | | | 44.5 | | | | 39.0 | | |
| 1851 | | | 67.6 | | | | 40.0 | | |
| 1852 | | 182.5 | 132.8 | | | 40.5 | 40.6 | | |
| 1853 | [b]132.5 | 155.0 | 155.5 | | [b]36.8 | 40.5 | 40.6 | | |
| 1854 | | 127.0 | 127.5 | | | 40.5 | 40.6 | | |
| 1855 | | 135.0 | 135.1 | | | 40.5 | 40.6 | | |
| 1856 | | 149.5 | 147.6 | | | 41.0 | 40.7 | | |
| 1857 | | 133.3 | 133.3 | | | 41.0 | 40.7 | | |
| 1858 | [b]134.1 | 124.0 | 124.7 | | [b]37.7 | 41.0 | 40.7 | | |
| 1859 | | 124.5 | 124.9 | | | 41.0 | 40.8 | | |
| 1860 | | 119.0 | 119.3 | | | 41.5 | 40.8 | | |
| 1861 | | 114.0 | 113.8 | | | 43.0 | 44.7 | | |
| 1862 | | 107.0 | 107.8 | | | 45.5 | 45.2 | | |
| 1863 | [b]123.0 | 106.5 | 107.0 | | [b]45.8 | 49.5 | 49.2 | | |
| 1864 | | 113.0 | 113.0 | | | 52.0 | 51.7 | | |
| 1865 | | 120.0 | 120.2 | | | 52.5 | 52.0 | | |
| 1866 | | 121.0 | 121.1 | | | 52.0 | 50.8 | | |
| 1867 | | 116.0 | 104.0 | | | 50.5 | 54.2 | | |
| 1868 | [b]129.6 | 120.0 | 109.7 | | [b]55.7 | 49.0 | 50.2 | | |
| 1869 | | 121.0 | 106.2 | | | 49.0 | 47.5 | | |
| 1870 | | 119.0 | 106.9 | | | 55.5 | 51.6 | | |
| 1871 | | 116.5 | 107.0 | | | 59.0 | 61.1 | | |
| 1872 | | 110.0 | 99.6 | | | 58.5 | 65.3 | | |
| 1873 | [b]115.6 | 111.5 | 96.2 | 96.2 | [b]81.9 | 64.0 | 89.3 | 82.1 | 81.8 |
| 1874 | | 107.5 | 90.8 | 90.8 | | 68.0 | 71.5 | 70.7 | 71.5 |
| 1875 | | 110.5 | 97.5 | 97.5 | | 69.0 | 80.5 | 77.6 | 80.5 |
| 1876 | 110.3 | 111.5 | 95.0 | 103.7 | 96.6 | 77.0 | 74.0 | 78.3 | 87.6 |
| 1877 | 119.3 | 117.0 | 97.0 | 114.0 | 99.3 | 87.0 | 81.0 | 75.2 | 81.0 |
| 1878 | 123.5 | 110.5 | 86.5 | 119.0 | 106.1 | 80.5 | 73.0 | 84.6 | 95.0 |
| 1879 | 119.2 | 104.0 | | 109.0 | 104.2 | 79.0 | | 83.4 | 96.0 |
| 1880 | 108.7 | 106.0 | | 106.5 | 103.1 | 87.5 | | 85.6 | 96.7 |
| 1881 | 105.6 | 103.0 | | 103.0 | 107.8 | 94.0 | | 89.8 | 102.0 |
| 1882 | 98.7 | 101.0 | | 102.0 | 115.1 | 102.5 | | 98.2 | 111.8 |
| 1883 | 96.1 | 98.0 | | 95.4 | 120.4 | 103.0 | | 99.0 | 115.3 |
| 1884 | 97.1 | 95.5 | | 101.7 | 122.9 | 104.0 | | 90.8 | 105.3 |
| 1885 | 102.7 | 97.5 | | 108.4 | 132.0 | 106.5 | | 97.6 | 118.5 |
| 1886 | 107.3 | | | 106.0 | 134.6 | | | 92.8 | 120.6 |
| 1887 | 106.3 | | | 105.8 | 141.9 | | | 94.0 | 124.3 |
| 1888 | 106.3 | | | 110.2 | 151.2 | | | 102.3 | 140.7 |
| 1889 | | | | 121.0 | | | | 114.9 | 158.8 |

[a] Figured from kilograms at United States coining value.

[b] Average for 5 preceding years.

Dr. Soetbeer's figures are in kilograms, and for the table have been reduced to United States coining values, by multiplying by $664.61393 per kilogram for gold and by $41.56764 per kilogram for silver. The figures in the same column for 1885 to 1888, inclusive, are from Dr. Soetbeer's memoir on the production of gold and silver from 1885 to 1888, presented to the International monetary congress, at Paris, in 1889.

The figures attributed to Sir Hector Hay are from a table furnished by him to the British commission on "Recent changes in the relative values of the precious metals" (1887). His figures, being given in pounds sterling, have been multiplied by 5 to convert them (approximately) into dollars.

The figures in the column headed "Mint report, 1880", are taken from a table published in the annual report of Hon. Horatio C. Burchard, director of the United States mint, on "Production of gold and silver in the United States" for 1880, page 294. The original authority for this table is not given. The close agreement of these figures between 1853 and 1866 with those given by Sir Hector Hay would indicate that both were taken from the same original source for these years.

The figures in the column headed "Mint report, 1889", are from the annual report of Hon. Edward O. Leech, director of the United States mint, on "Production of gold and silver in the United States" for the year 1889, page 61.

In comparing the figures for silver since 1873 it must be noted that the column headed "Soetbeer" and one of the two columns "Mint report, 1889," give the United States coining value at $1.2929 per ounce fine, while the other three columns give the commercial value, based on the market price for each year, which value had declined from $1.29 to $0.935 between 1873 and 1889. The figures given in the table have been plotted in the diagram herewith presented, which shows more clearly than the figures themselves both the general trend of variation in the production of gold and silver during the 40 years under consideration and the differences in the estimates of the several authorities.

Considering first the line in the diagram representing the gold production, it is noticed that from 1849 to 1853 the production as given in the table in the report of the director of the mint for 1880 (the original authority of which is not given), as given by Soetbeer (average production from 1850 to 1855), and as given by Sir Hector Hay differ so greatly that there can be no possible means of reconciling them. From 1853 to 1866 Sir Hector Hay's figures practically coincide with those in the mint director's report, showing that they must have been taken from the same original source, while Soetbeer's figures of averages show an approximate agreement with them, but are generally higher. From 1861 to 1874 Sir Hector Hay's figures part company with those of the director of the mint and approach those of Soetbeer, which remain the highest of the three, the director's figures going very much lower, reaching a minimum of 90.8 millions of dollars in 1874, against Sir Hector Hay's figures of 107 millions for that year and Soetbeer's figures of 115.6 millions as the average of the years 1870 to 1875. In 1878 the mint director's figures (report of 1880) reach a still lower minimum of 86.5 millions; but in 1873 a new series of figures begins, taken from the report of the director of the mint of 1889, which, while coinciding with the earlier table for the years 1873, 1874, and 1875, afterward depart so rapidly in the direction of Soetbeer's higher figures as to show 119 millions in 1878, against only 86.5 millions for the same year in the earlier table. This new table of the director of the mint (report of 1889), thus approaching Soetbeer's figures in 1876, thereafter shows a substantial agreement with Soetbeer; Sir Hector Hay's figures at times nearly coincide with them, but at others differ somewhat widely.

The 10 volumes of the report of the director of the mint from 1870 to 1889, inclusive, give tables of the world's production for the 3 or 4 years prior to the date of each volume, distributing the production among different countries. These estimates are made in some cases from official reports obtained by United States consular officers, and in others from technical or financial papers published in those countries; in others by taking Soetbeer's figures. Soetbeer's estimates are likewise made in a similar way; in many cases he accepts the figures of the director of the mint. The figures of Soetbeer and those of the director of the mint are therefore partly independent of and partly dependent upon each other. Since there is a substantial agreement between their figures between 1876 and 1888, and there is no strong reason for preferring one of these authorities to the other, it may safely be assumed that if a curved line be drawn through the diagram representing the figures of each, bisecting their differences as nearly as possible, it will give as near an approximation to the most probable figures as can be obtained. For the years 1857 to 1876 the figures of Sir Hector Hay and Soetbeer appear to agree with each other somewhat more closely than either set agrees with the figures given in the report of the director of the mint for 1880 (authority not given). There seems, therefore, to be a reason for rejecting the latter figures and drawing a curved line which will approximately bisect the differences of Sir Hector Hay and Soetbeer.

Previous to 1857 the figures given by Sir Hector Hay and by the director of the mint differ so widely from those of Soetbeer (except in 1854 and 1857), and previous to 1853 from each other, that Soetbeer's average figures must be accepted, in the absence of any other evidence, as the most probable.

Drawing an irregular curved line on the diagram as thus described, the figures of the most probable value of the world's product of gold from 1850 to 1889, are obtained as follows:

THE WORLD'S GOLD PRODUCTION.

[Probable values in millions of dollars.]

| | |
|---|---|
| 1850 to 1855 | [a]132.5 |
| 1856 | 134.0 |
| 1857 | 134.0 |
| 1858 | 133.0 |
| 1859 | 130.0 |
| 1860 | 127.0 |
| 1861 | 122.0 |
| 1862 | 119.0 |
| 1863 | 119.0 |
| 1864 | 122.0 |
| 1865 | 126.0 |
| 1866 | 127.0 |
| 1867 | 127.0 |
| 1868 | 126.0 |
| 1869 | 125.0 |
| 1870 | 123.0 |
| 1871 | 119.0 |
| 1872 | 113.0 |
| 1873 | 112.0 |
| 1874 | 111.0 |
| 1875 | 111.0 |
| 1876 | 111.0 |
| 1877 | 116.0 |
| 1878 | 120.0 |
| 1879 | 114.0 |
| 1880 | 108.0 |
| 1881 | 104.0 |
| 1882 | 100.0 |
| 1883 | 97.0 |
| 1884 | 100.0 |
| 1885 | 106.0 |
| 1886 | 106.0 |
| 1887 | 106.0 |
| 1888 | 110.0 |
| 1889 | 120.0 |

[a] Average for 5 preceding years.

Referring now to the lines on the diagram representing the silver production, it is noted that from 1850 to 1875 there is a substantial agreement between the figures given by Sir Hector Hay, Soetbeer, and the director of the mint (except that Sir Hector Hay's figures drop far below Soetbeer's in the years 1871 to 1874). It is easy, therefore, to draw a line which shall represent the most probable value between these dates.

After 1874, when the commercial value began to differ widely from the United States coining value, Sir Hector Hay's figures, being commercial values, are omitted from the diagram, and the figures of Soetbeer and the director of the mint only are given. Between these dates there is a wide difference between the figures of Soetbeer and the director of the mint, those of the former being invariably the higher. An attempt has been made to learn the cause of this difference by comparing the figures given by each of these authorities for the principal silver-producing countries, as shown in the table herewith headed "Comparison of estimates of Dr. Soetbeer and the director of the United States mint", and also by referring to Dr. Soetbeer's own explanation of the difference as given in his paper presented at the Paris monetary congress in 1889, already mentioned.

The following quotation is from Dr. Soetbeer's paper (translation):

> A fundamental difference exists in the method in accordance with which the shares of the different countries in the total production of the precious metals should be calculated, and material variances in the estimates occur. To illustrate the difference of the method just referred to the following example is given:

THE PRODUCTION OF SILVER IN GERMANY.

| YEARS. | GERMAN REPORT. (*a*) | | MINT REPORT, 1887. (*b*) | |
|---|---|---|---|---|
| | Product. (Kilograms.) | Value. (Marks.) | Product. (Kilograms.) | Value. |
| 1885 | 309,418 | 44,137,793 | 24,507 | $1,021,000 |
| 1886 | 319,598 | 42,707,549 | 25,650 | 1,066,000 |
| 1887 | 367,633 | 48,158,010 | 23,929 | 994,000 |
| 1888 | 406,567 | 51,425,269 | | |
| 1889 | | | | |

*a* From official statistics of the German empire.

*b* From report of the director of the mint upon production of the precious metals, 1887.

> According to this the American report estimates the silver production of Germany at only about 18 per cent and 6 per cent, respectively, of the amount the imperial statistics positively give for it. The reason for this enormous difference is that the latter give the exact product of the German smelting works (inclusive of the working of imported foreign argentiferous ores, etc.), while the director of the mint of the United States gives as the production of silver in Germany only the presumptive silver contents of German silver ores. In the case of gold, which in Germany is, we may say, obtained almost exclusively from foreign ores, the production of the German smelting works is given in the American report (1887) at 2,251 kilograms fine, as the gold production of Germany.
>
> As a self-evident consequence of the calculation of the production of the precious metals not according to the gross exploitation of the mines, but according to the product of the smelting works, the amounts of gold and silver ores, which in the statistics of many countries were first included in the precious metal production of these countries, must be deducted from our estimate—a deduction which, in many cases, can be made only with the reservation of a very broad margin for possible errors.

Dr. Soetbeer says elsewhere in the same paper:

> The presumptive silver contents of the domestic ores exported from the United States is embraced in the figures of the director of the mint, but not the silver obtained from foreign imported ores.
>
> According to our method, which, in the distribution of the production of silver among the different countries, as remarked above, keeps in view the ultimate amount of silver obtained, the reverse of this would have to be done. Now, as in the United States there has been a large quantity of foreign (especially Mexican) silver and other argentiferous ores imported and treated, the above production of silver appears in our table higher than in the report of the director of the mint, which higher figure is, of course, compensated for in the table of the world's production by the fact that like amounts in the silver production of those countries from which the ores were drawn are deducted. It is necessary to proceed here with the greatest caution, making all possible reservation in our approximate estimates, for the reason that there is no accurate information as to the amount of metal that was contained in the ores, even if the amount of exported ores be given approximately correct.

Referring to the uncertain nature of all statistics of production of the precious metals, Dr. Soetbeer says:

> The longer and more zealously a conscientious investigator busies himself with the statistics of the production and employment of the precious metals the more will he be convinced that, with some exceptions, the numerical results obtainable relating to such production and employment are of a very uncertain nature; that they possess only the character of a greater or less approach to the reality, and of greater or less probability; that the round numbers laid before the student deserve confidence because apparently most carefully calculated on positive data, and that a continual revision of the estimates seems desirable.
>
> The total amount of the precious metals newly produced during the period of 38 years from 1851 to 1888 must be assumed approximately as follows:

APPROXIMATE PRODUCTION OF PRECIOUS METALS. 1851 TO 1888.

| METALS. | Quantity. (Kilograms.) | Value. (Million marks.) |
|---|---|---|
| Gold | 7,019,338 | 19,584.7 |
| Silver | 71,037,631 | 11,401.6 |

Enormous as these sums appear, we believe that in reality the quantities of new silver, and especially of new gold, put upon the market since 1851 are greater rather than smaller than the amounts given above, for in the case of the production of many countries, especially that of Russia and Mexico, for which our tables contain only the declared amounts, it is very probable that the portion which from year to year has escaped declaration and registration is many millions of marks in value, and the several scattered small amounts produced which are not mentioned in the statistics, each of which is, as compared with the world's production, insignificant, constitute, when taken together, considerable sums.

### THE WORLD'S SILVER PRODUCTION—COMPARISON OF ESTIMATES OF DR. SOETBEER AND THE DIRECTOR OF THE UNITED STATES MINT.

[Thousands of kilograms.]

| YEARS. | TOTAL. | | UNITED STATES. | | MEXICO. | | BOLIVIA, PERU, CHILE. | | | | GERMANY. | | OTHER COUNTRIES. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Director of mint. | Soetbeer. | Director of mint. | Soetbeer. | Director of mint. | Soetbeer. | Director of mint. | | | Soetbeer. | Director of mint. | Soetbeer. | Director of mint. | Soetbeer. |
| | | | | | | | (a) | (b) | (c) | | | | | |
| 1877 | 2,175 | 2,389 | 957 | 957 | 650 | 634 | ...... | 250 | ...... | 350 | 148 | 148 | 170 | 300 |
| 1878 | 2,293 | 2,551 | 1,089 | 1,089 | 650 | 644 | ...... | 250 | ...... | 350 | 126 | 168 | 178 | 300 |
| 1879 | 2,314 | 2,508 | 982 | 981 | 605 | 699 | 265 | 122 | ...... | 350 | 134 | 178 | 206 | 300 |
| 1880 | 2,275 | 2,480 | [illegible] | 943 | 605 | 701 | 265 | 122 | ...... | 350 | 134 | 186 | 206 | 300 |
| 1881 | 2,458 | 2,593 | 1,035 | 1,035 | 666 | 721 | 265 | 122 | ...... | 350 | 187 | 187 | 183 | 300 |
| 1882 | 2,690 | 2,769 | 1,126 | 1,126 | 704 | 738 | 265 | 128 | 46 | 390 | 215 | 215 | 206 | 300 |
| 1883 | 2,774 | 2,895 | 1,112 | 1,111 | 711 | 739 | 385 | 160 | 46 | 510 | 143 | 235 | 217 | 300 |
| 1884 | 2,538 | 2,957 | 1,174 | 1,174 | 656 | 785 | 241 | 160 | 46 | 450 | 28 | 248 | 233 | 300 |
| 1885 | 2,842 | 3,175 | 1,242 | 1,295 | 773 | 736 | 241 | 210 | 48 | 455 | 25 | 309 | 303 | 380 |
| 1886 | 2,897 | 3,238 | 1,227 | 1,288 | 794 | 792 | 241 | 210 | 96 | 460 | 26 | 320 | 303 | 378 |
| 1887 | 2,992 | 3,414 | 1,284 | 1,374 | 904 | 784 | 137 | 200 | 75 | 435 | 32 | 368 | 360 | 453 |
| 1888 | 3,424 | 3,637 | 1,424 | 1,540 | 995 | 800 | 230 | 186 | 75 | 430 | 32 | 407 | 482 | 460 |
| 1889 | 3,920 | .......... | 1,555 | .......... | 1,336 | .......... | 230 | 186 | 75 | .......... | 32 | .......... | 506 | .......... |

*a* Bolivia. *b* Peru. *c* Chile.

Referring again to the diagram of silver production, it will be noticed that in the year 1884 the figures given by the director of the mint are not only far below Soetbeer's, but they are also far below his own figures for 1883 and 1885, the years immediately preceding and following.

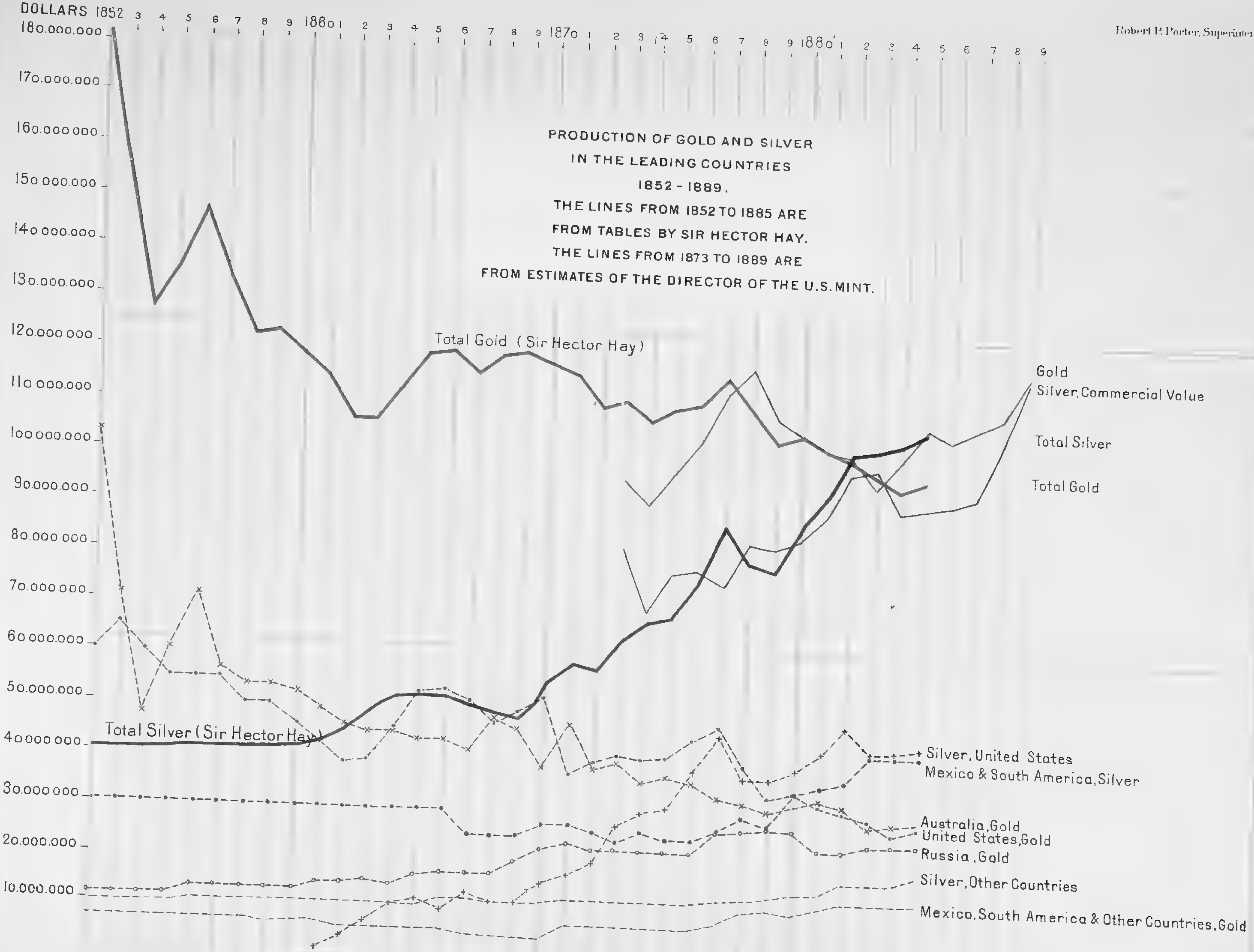
Referring to the table of comparison by countries, it is seen that this apparent decline in production is found in Mexico, where the director reports a decrease of 55,000 kilograms, as against an increase of 46,000 kilograms reported by Soetbeer; in Bolivia, where the director reports a decrease of 141,000 kilograms, against a decrease of 60,000 reported by Soetbeer, and in Germany an apparent decrease of 115,000 kilograms is reported by the director of the mint, against an increase of 13,000 kilograms reported by Soetbeer. The apparent decrease in Germany is due to a change in the method of estimating the German product, as mentioned in the above-quoted extracts of Dr. Soetbeer. Prior to 1884 the figures were made by taking the returns of the smelting works and deducting 88,000 kilograms as the estimated amount of silver contained in imported foreign ores. In 1384 and succeeding years the product is that of the German mines reckoned directly. The director of the mint in his report of 1889 says:

> The silver product credited to Germany, however, is the product of its own mines, as shown by its statistical publications. The value of silver contained in exported ores is reported to this bureau by the exporting countries as part of the annual product of their mines, and is credited to the producing countries rather than to the smelting works of Germany.

It would appear, however, from the figures of 1884 that the countries exporting to Germany were either not so credited to the proper extent, or else that there was a remarkable decrease in their production that year.

It may be that in previous years the product was duplicated in the report of the director of the mint, the same bullion being credited both to the country that produced the ore and the country that smelted it. On the other hand, it is possible that in recent years the product has been similarly duplicated by Soetbeer in crediting Germany with the silver produced from imported ores and not deducting this amount from that reported by foreign countries.

Without further evidence than is now at hand as to the preponderance of weight of these two authorities, it is not possible for an impartial student to form a definite conclusion as to which is more likely to give the nearest approximate to correct figures. The diagram would indicate that the decrease of production shown by the mint director's figures for the years 1877 and 1884 is improbable, in view of the fact that there is a general tendency of the production to increase throughout the whole of the last 30 years and that Soetbeer shows no decrease for these years.



PRODUCTION OF GOLD AND SILVER
IN THE LEADING COUNTRIES
1852 - 1889.
THE LINES FROM 1852 TO 1885 ARE
FROM TABLES BY SIR HECTOR HAY.
THE LINES FROM 1873 TO 1889 ARE
FROM ESTIMATES OF THE DIRECTOR OF THE U.S. MINT.

In drawing the curve of probable production from 1875 to 1889, the mint director's figures for the years 1877 and 1884 have therefore been rejected, and as even a curve has been drawn as possible between the lines in the diagram representing the figures of the two authorities for the other years. The complete curve then gives the following figures from 1850 to 1889:

### WORLD'S PRODUCTION OF SILVER.

[Probable values, in millions of dollars, based on United States coining value of $1.2929 per ounce fine.]

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1850 to 1860 (*a*) | 40 | 1865 | 52 | 1870 | 64 | 1875 | 82 | 1880 | 101 | 1885 | 125 |
| 1861 | 45 | 1866 | 52 | 1871 | 68 | 1876 | 88 | 1881 | 106 | 1886 | 130 |
| 1862 | 46 | 1867 | 54 | 1872 | 71 | 1877 | 93 | 1882 | 111 | 1887 | 136 |
| 1863 | 49 | 1868 | 57 | 1873 | 75 | 1878 | 97 | 1883 | 115 | 1888 | 146 |
| 1864 | 52 | 1869 | 61 | 1874 | 79 | 1879 | 99 | 1884 | 120 | 1889 | 159 |

*a* Average for preceding 10 years.

### WORLD'S PRODUCTION, BY COUNTRIES, OF GOLD AND SILVER FROM 1880 TO 1889.

The following estimates of the gold and silver production of the world are taken from the reports of the director of the United States mint on the production of gold and silver in the United States. The figures for 1880 are from the report of 1882, those for 1881 from the report of 1884, those for 1882 from the report of 1885, those for 1883 from the report of 1887, those for 1884, 1885, and 1886 from the report of 1888, and those for 1887, 1888, and 1889 from the report of 1890.

### WORLD'S PRODUCTION OF GOLD AND SILVER FROM 1880 TO 1889, AS ESTIMATED BY THE DIRECTOR OF THE MINT.

| COUNTRIES. | 1880. | | | | 1881. | | | |
|---|---|---|---|---|---|---|---|---|
| | Gold. | | Silver. | | Gold. | | Silver. | |
| | Kilograms. | Dollars. | Kilograms. | Dollars. | Kilograms. | Dollars. | Kilograms. | Dollars. |
| Total | 160, 152 | 106, 436, 786 | 2, 275, 082 | 94, 551, 060 | 155, 016 | 103, 023, 078 | 2, 458, 322 | 102, 168, 354 |
| United States | 54, 168 | 36, 000, 000 | 942, 987 | 39, 200, 000 | 52, 212 | 34, 700, 000 | 1, 034, 649 | 43, 000, 000 |
| Australasia | 43, 282 | 28, 765, 000 | 5, 465 | 227, 125 | *a*46, 178 | 30, 690, 000 | *b*3, 970 | 164, 983 |
| Mexico | *c*1, 488 | 989, 160 | *c*605, 469 | 25, 167, 763 | *d*1, 292 | 858, 909 | *d*665, 918 | 27, 675, 540 |
| European countries: | | | | | | | | |
| Russia | *c*42, 960 | 28, 551, 028 | *c*11, 391 | 473, 519 | 36, 671 | 24, 371, 343 | 7, 992 | 332, 198 |
| Germany | *e*350 | 232, 610 | *e*134, 152 | 5, 576, 699 | *f*350 | 232, 610 | *g*186, 990 | 7, 771, 304 |
| Austria-Hungary | 1, 647 | 1, 094, 596 | 48, 000 | 1, 994, 880 | 1, 867 | 1, 240, 808 | 31, 359 | 1, 303, 280 |
| Sweden | 5 | 3, 323 | 1, 312 | 54, 527 | 1 | 665 | 1, 176 | 48, 875 |
| Norway | ........ | ........ | 4, 436 | 184, 360 | ........ | ........ | 4, 812 | 199, 987 |
| Italy | *h*109 | 72, 375 | *i*432 | 17, 949 | *j*109 | 72, 375 | *j*432 | 17, 949 |
| Spain | ........ | ........ | 74, 500 | 3, 096, 220 | ........ | ........ | *k*74, 500 | 3, 096, 220 |
| Turkey | 7 | 4, 918 | 1, 719 | 71, 441 | 7 | 4, 918 | 1, 719 | 71, 441 |
| France | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Great Britain | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Dominion of Canada | 1, 226 | 815, 089 | 1, 641 | 68, 205 | 1, 648 | 1, 094, 926 | 1, 641 | 68, 205 |
| South American countries: | | | | | | | | |
| Argentine Republic | *c*118 | 78, 546 | *c*10, 109 | 420, 225 | *l*118 | 78, 546 | *l*10, 109 | 420, 225 |
| Colombia | *c*6, 019 | 4, 000, 000 | *c*24, 057 | 1, 000, 000 | *l*6, 019 | 4, 000, 000 | *l*24, 057 | 1, 000, 000 |
| Bolivia | *m*109 | 72, 345 | *m*264, 677 | 11, 000, 000 | 109 | 72, 375 | 264, 677 | 11, 000, 000 |
| Chile | *m*194 | 128, 869 | *m*122, 275 | 5, 081, 747 | 194 | 128, 869 | 122, 275 | 5, 081, 747 |
| Brazil | 1, 345 | 893, 887 | ........ | ........ | 1, 116 | 741, 694 | ........ | ........ |
| Venezuela | 3, 423 | 2, 274, 692 | ........ | ........ | *k*3, 423 | 2, 274, 692 | ........ | ........ |
| Guiana (British) | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Guiana (Dutch) | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Peru | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Central American states | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Japan | *c*702 | 466, 548 | *c*22, 460 | 916, 400 | *l*702 | 466, 548 | *l*22, 046 | 916, 400 |
| Africa | *c*3, 000 | 1, 993, 800 | ........ | ........ | *g*3, 000 | 1, 993, 800 | ........ | ........ |
| China | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| India (British) | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |

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*a* Official for Victoria and New South Wales, with estimated production of the other provinces.

*b* The mean of the official production for 1880 and 1882.

*c* Estimated the same as 1879.

*d* Coinage and export.

*e* From total production 17 per cent of gold and 25 per cent of silver deducted for foreign ores.

*f* Estimated same as official statement for 1880.

*g* Estimated by Dr. A. Soetbeer.

*h* Estimated.

*i* Dr. A. Soetbeer.

*j* Estimated same as official statement for 1877.

*k* Estimated same as official statement for 1880.

*l* Estimated same as official statement for 1879.

*m* Estimated same as 1881.

WORLD'S PRODUCTION OF GOLD AND SILVER, ETC.—Continued.

| COUNTRIES. | 1882. | | | | 1883. | | | |
|---|---|---|---|---|---|---|---|---|
| | Gold. | | Silver. | | Gold. | | Silver. | |
| | Kilograms. | Dollars. | Kilograms. | Dollars. | Kilograms. | Dollars. | Kilograms. | Dollars. |
| Total | 153, 470 | 101, 996, 640 | 2, 690, 109 | 111, 802, 337 | 143, 533 | 95, 392, 000 | 2, 774, 227 | 115, 297, 000 |
| United States | 48, 902 | 32, 500, 000 | 1, 126, 083 | 46, 800, 000 | 45, 140 | 30, 000, 000 | 1, 111, 646 | 46, 200, 000 |
| Australasia | 48, 081 | 31, 955, 017 | 2, 011 | 83, 592 | 40, 852 | 27, 150, 000 | 3, 610 | 150, 000 |
| Mexico | 1, 409 | 936, 223 | 703, 508 | 29, 237, 798 | 1, 438 | 956, 000 | 711, 480 | 29, 569, 000 |
| European countries: | | | | | | | | |
| Russia | 35, 913 | 23, 867, 935 | 7, 781 | 323, 427 | 30, 272 | 20, 119, 000 | 9, 990 | 415, 000 |
| Germany | 376 | 249, 890 | 214, 982 | 8, 934, 652 | 458 | 304, 000 | *a*142, 700 | 5, 930, 000 |
| Austria-Hungary | *b*1, 580 | 1, 050, 068 | *b*47, 118 | 1, 958, 224 | 1, 638 | 1, 088, 000 | 48, 700 | 2, 024, 000 |
| Sweden | 17 | 11, 298 | 1, 500 | 62, 350 | 37 | 25, 000 | 1, 583 | 66, 000 |
| Norway | | | 5, 893 | 244, 954 | | | 5, 645 | 235, 000 |
| Italy | *c*109 | 72, 375 | *c*432 | 17, 949 | *d*142 | 94, 000 | *d*29, 259 | 1, 216, 000 |
| Spain | | | *e*74, 500 | 3, 096, 220 | | | *f*54, 335 | 2, 258, 000 |
| Turkey | 10 | 6, 646 | 2, 164 | 89, 916 | *d*10 | 7, 000 | *d*1, 323 | 55, 000 |
| France | | | 14, 291 | 594, 053 | | | 6, 356 | 264, 000 |
| Great Britain | | | | | 2 | 1, 000 | 8, 500 | 353, 000 |
| Dominion of Canada | *g*1, 648 | 1, 094, 926 | *g*1, 641 | 68, 205 | 1, 435 | 954, 000 | *d*5, 030 | 209, 000 |
| South American countries: | | | | | | | | |
| Argentine Republic | *h*118 | 78, 546 | *h*10, 109 | 420, 225 | 118 | 78, 000 | 11, 500 | 478, 000 |
| Colombia | 5, 802 | 3, 856, 000 | 18, 283 | 760, 000 | *i*5, 802 | 3, 856, 000 | *i*18, 287 | 760, 000 |
| Bolivia | *g*109 | 72, 375 | *g*264, 677 | 11, 000, 000 | 109 | 72, 000 | 384, 985 | 16, 000, 000 |
| Chile | 245 | 163, 000 | 128, 106 | 5, 325, 000 | *j*500 | 332, 000 | *j*160, 000 | 6, 650, 000 |
| Brazil | *g*1, 116 | 741, 694 | | | 952 | 633, 000 | | |
| Venezuela | 3, 904 | 2, 595, 077 | | | 5, 023 | 3, 338, 000 | | |
| Guiana (British) | | | | | | | | |
| Guiana (Dutch) | | | | | | | | |
| Peru | *k*179 | 119, 250 | *k*45, 909 | 1, 908, 000 | *j*180 | 120, 000 | *j*45, 909 | 1, 908, 000 |
| Central American states | | | | | | | | |
| Japan | *l*952 | 632, 520 | *l*21, 121 | 877, 772 | *i*290 | 193, 000 | *i*12, 940 | 538, 000 |
| Africa | *m*3, 000 | 1, 993, 800 | | | *n*1, 078 | 717, 000 | 449 | 19, 000 |
| China | | | | | *o*8, 057 | 5, 355, 000 | | |
| India (British) | | | | | | | | |

*a* The production officially reported with a deduction of 88,000 kilograms, given by Dr. Soetbeer for 1884 as the amount from foreign ores smelted.

*b* Official for Hungary, with former annual production for Austria added.

*c* Estimated same as official statement for 1877.

*d* Estimated same as officially communicated for 1886.

*e* Estimated same as official statement for 1880.

*f* Estimate of Dr. Soetbeer for 1883.

*g* Estimated same as official statement for 1881.

*h* Estimated same as official statement for 1879.

*i* Estimated same as officially communicated for 1882.

*j* Estimated same as officially communicated for 1884.

*k* Estimated same as official statement for 1884.

*l* Estimated same as official statement for 1883.

*m* Estimated by Dr. A. Soetbeer, 1879.

*n* Imported into the United Kingdom from West and South Africa, extracted from board of trade returns by A. Sauerbeck, F. S. S.

*o* Dr. Ivan C. Michels.

WORLD'S PRODUCTION OF GOLD AND SILVER, ETC.—Continued.

| COUNTRIES. | 1884. | | | | 1885. | | | |
|---|---|---|---|---|---|---|---|---|
| | Gold. | | Silver. | | Gold. | | Silver. | |
| | Kilograms. | Dollars. | Kilograms. | Dollars. | Kilograms. | Dollars. | Kilograms. | Dollars. |
| Total | 153, 070 | 101, 729, 600 | 2, 537, 564 | 105, 461, 350 | 156, 156 | 103, 779, 600 | 2, 841, 573 | 118, 095, 150 |
| United States | 46, 344 | 30, 800, 000 | 1, 174, 206 | 48, 800, 000 | 47, 848 | 31, 800, 000 | 1, 241, 578 | 51, 600, 000 |
| Australasia | 42, 558 | 28, 284, 000 | 4, 525 | 188, 000 | 41, 287 | *a*27, 439, 000 | 25, 220 | 1, 048, 000 |
| Mexico | 1, 780 | 1, 183, 000 | 655, 870 | 27, 258, 000 | 1, 304 | 867, 000 | 772, 670 | 32, 112, 000 |
| European countries: | | | | | | | | |
| Russia | 32, 913 | 21, 874, 000 | 9, 360 | 389, 000 | 38, 125 | 25, 338, 000 | 15, 550 | 646, 000 |
| Germany | 555 | 369, 000 | 27, 598 | 1, 147, 000 | 1, 378 | 916, 000 | 24, 567 | 1, 021, 000 |
| Austria-Hungary | 1, 658 | 1, 102, 000 | 49, 300 | 2, 049, 000 | 1, 774 | 1, 179, 000 | 52, 748 | 2, 192, 200 |
| Sweden | 20 | 13, 000 | 1, 816 | 75, 500 | 47 | 31, 000 | 2, 326 | 96, 000 |
| Norway | | | 6, 387 | 265, 500 | | | 7, 200 | 299, 000 |
| Italy | *b*195 | 129, 600 | *b*33, 839 | 1, 406, 350 | *b*195 | 129, 600 | *b*33, 839 | 1, 406, 350 |
| Spain | | | *c*54, 335 | 2, 258, 000 | | | *c*54, 335 | 2, 258, 000 |
| Turkey | *b*10 | 7, 000 | *b*1, 323 | 55, 000 | *b*10 | 7, 000 | *b*1, 323 | 55, 000 |
| France | | | 5, 905 | 245, 000 | | | 51, 000 | 2, 120, 000 |
| Great Britain | | | 8, 060 | 335, 000 | | | 7, 607 | 316, 000 |
| Dominion of Canada | *d*1, 435 | 954, 000 | *b*5, 030 | 209, 000 | 1, 679 | 1, 116, 000 | *b*5, 030 | 209, 000 |
| South American countries: | | | | | | | | |
| Argentine Republic | *d*118 | 78, 000 | *d*11, 500 | 478, 000 | *d*118 | 78, 000 | *d*11, 500 | 478, 000 |
| Colombia | *e*5, 802 | 3, 856, 000 | *e*18, 287 | 760, 000 | *b*3, 762 | 2, 500, 000 | *b*9, 625 | 400, 000 |
| Bolivia | *d*109 | 72, 000 | *f*240, 616 | 10, 000, 000 | *d*109 | 72, 000 | *f*240, 616 | 10, 000, 000 |
| Chile | 500 | 332, 000 | 160, 000 | 6, 650, 000 | *b* 500 | 332, 000 | *b*210, 000 | 8, 727, 600 |
| Brazil | *d* 952 | 633, 000 | | | 1, 204 | 800, 000 | 2, 640 | 110, 000 |
| Venezuela | *g*7, 033 | 4, 674, 000 | | | 7, 033 | 4, 674, 000 | | |
| Guiana (British) | | | | | | | | |
| Guiana (Dutch) | | | | | | | | |
| Peru | 180 | 120, 000 | 45, 909 | 1, 908, 000 | 226 | 150, 000 | 47, 840 | 1, 988, 000 |
| Central American states | | | | | 9 | 6, 000 | | |
| Japan | 296 | 197, 000 | 23, 460 | 975, 000 | 265 | 176, 000 | 23, 085 | 960, 000 |
| Africa | *g*1, 250 | 830. 000 | *h* 238 | 10, 000 | *h*2, 083 | 1, 384, 000 | *h*1, 274 | 53, 000 |
| China | *h*9, 362 | 6, 222, 000 | | | *i* 6, 997 | 4, 650, 000 | | |
| India (British) | | | | | 203 | 135, 000 | | |

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*a* G. W. Griffin, United States consul at Sydney, reports the gold production of Australasia for 1886 at $25,883,884, and for 1885 at $27,361,603.

*b* Estimated same as officially communicated for 1886.

*c* Estimate of Dr. Soetbeer for 1883.

*d* Estimate of the bureau of the mint, based upon the production for 1883.

*e* Estimated same as officially communicated for 1882.

*f* Estimate of the bureau of the mint, based upon the annual average credited Bolivia by Dr. A. Soetbeer, and confirmed by official statistics of exports and coinage for 1887.

*g* Estimate of the bureau of the mint, based upon the production for 1885.

*h* Imports into the United Kingdom from West and South Africa, extracted from board of trade returns by A. Sauerbeck, F. S. S.

Dr. Ivan C. Michels.

WORLD'S PRODUCTION OF GOLD AND SILVER—Continued.

| COUNTRIES. | 1886. | | | | 1887. | | | |
|---|---|---|---|---|---|---|---|---|
| | Gold. | | Silver. | | Gold. | | Silver. | |
| | Kilograms. | Dollars. | Kilograms. | Dollars. | Kilograms. | Dollars. | Kilograms. | Dollars. |
| Total | 149, 338 | 99, 250, 877 | 2, 896, 882 | 120, 394, 400 | 159, 155 | 105, 774, 955 | 2, 990, 398 | 124, 280, 978 |
| United States | 52, 663 | 35, 000, 000 | 1, 227, 141 | 51, 000, 000 | 49, 654 | 33, 000, 000 | 1, 283, 855 | 53, 357, 000 |
| Australasia | 39, 761 | *a*26, 425, 000 | 29, 403 | 1, 222, 000 | 41, 119 | 27, 327, 600 | 6, 422 | 266, 900 |
| Mexico | 924 | 614, 000 | 794, 033 | 33, 000, 000 | 1, 240 | 824, 000 | 904, 000 | 37, 570, 000 |
| European countries: | | | | | | | | |
| Russia | 30, 872 | 20, 518, 000 | 12, 707 | 528, 100 | 30, 232 | 20, 092, 000 | 13, 522 | 562, 000 |
| Germany | 1, 065 | 708, 000 | 25, 650 | 1, 066, 000 | 2, 251 | 1, 496, 000 | 31, 564 | 1, 311, 798 |
| Austria-Hungary | *b*1, 774 | 1, 179, 000 | *b*52, 748 | 2, 192, 200 | 1, 877 | 1, 247, 450 | 53, 391 | 2, 218, 900 |
| Sweden | 67 | 45, 000 | 3, 081 | 128, 000 | 84 | 55, 550 | *c*5, 828 | 242, 250 |
| Norway | ........ | ........ | *b*7, 200 | 299, 000 | ........ | ........ | *d*5, 147 | 214, 000 |
| Italy | 195 | 129, 600 | 33, 839 | 1, 406, 350 | *c*195 | 129, 600 | *c*33, 839 | 1, 406, 350 |
| Spain | ........ | ........ | *e*54, 335 | 2, 258, 000 | ........ | ........ | 58, 711 | 2, 440, 000 |
| Turkey | 10 | 7, 000 | 1, 323 | 55, 000 | *c*10 | 7, 000 | *c*1, 323 | 55, 000 |
| France | ........ | ........ | 46, 789 | 1, 944, 550 | ........ | ........ | 54, 314 | 2, 257, 300 |
| Great Britain | ........ | ........ | 10, 124 | 420, 750 | 2 | 1, 000 | 9, 964 | 414, 100 |
| Dominion of Canada | 2, 002 | 1, 330, 442 | 5, 030 | 209, 000 | 1, 773 | 1, 178, 637 | 10, 868 | 451, 680 |
| South American countries: | | | | | | | | |
| Argentine Republic | 30 | 20, 000 | 1, 444 | 60, 000 | 45 | 30, 000 | 722 | 30, 000 |
| Colombia | 3, 762 | 2, 500, 000 | 9, 625 | 400, 000 | 4, 514 | 3, 000, 000 | 24, 061 | 1, 000, 000 |
| Bolivia | *f*109 | 72, 000 | *g*240, 616 | 10, 000, 000 | 143 | 95, 000 | 137, 468 | 5, 713, 170 |
| Chile | 500 | 332, 000 | 210, 000 | 8, 727, 600 | 2, 379 | 1, 581, 400 | 199, 516 | 8, 291, 920 |
| Brazil | *h*1, 502 | 998, 000 | *h*141 | 5, 850 | 984 | 654, 000 | ........ | ........ |
| Venezuela | *i*5, 020 | 3, 336, 000 | ........ | ........ | 2, 960 | 1, 967, 216 | ........ | ........ |
| Guiana (British) | ........ | ........ | ........ | ........ | 370 | 245, 902 | ........ | ........ |
| Guiana (Dutch) | ........ | ........ | ........ | ........ | 712 | *j*473, 000 | ........ | ........ |
| Peru | *k*170 | 113, 000 | *k*96, 246 | 4, 000, 000 | *d*158 | 105, 000 | *l*75, 263 | 3, 128, 000 |
| Central American states | *m*131 | 87, 000 | ........ | ........ | 226 | *n*150, 000 | 48, 123 | *n*2, 000, 000 |
| Japan | 492 | 327, 235 | 32, 242 | 1, 340, 000 | 564 | 375, 000 | 32, 065 | 1, 332, 650 |
| Africa | *o*2, 163 | 1, 438, 000 | 3, 165 | 132, 000 | 2, 888 | 1, 919, 600 | 432 | 17, 960 |
| China | *p*5, 492 | 3, 650, 000 | ........ | ........ | *p*14, 294 | 9, 500, 000 | ........ | ........ |
| India (British) | 634 | 421, 600 | ........ | ........ | 481 | 320, 000 | ........ | ........ |

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*a* G. W. Griffin, United States consul at Sydney, reports the gold production of Australasia for 1886 at $25,883,884, and for 1885 at $27,361,603.

*b* Estimate of the bureau of the mint, based upon the production for 1885.

*c* Estimated the same as officially communicated for 1886.

*d* Estimated the same as officially communicated for 1889.

*e* Estimate of Dr. Soetbeer for 1883.

*f* Estimate of the bureau of the mint, based upon the production for 1883.

*g* Estimate of the bureau of the mint, based upon the annual average credited Bolivia by Dr. A. Soetbeer and confirmed by official statistics of exports and coinage for 1887.

*h* Exports of gold and silver through the customhouse at Rio de Janeiro.

*i* Production of 2 mills of the El Callao Company.

*j* "Jaarcijifers over 1888 en Vorige Jaaren", No. 8, page 115.

*k* Estimate of the bureau of the mint, based upon the exports of bullion and ore officially reported for 1886.

*l* Estimated the same as officially communicated for 1888.

*m* Estimated same as officially communicated for 1887.

*n* Rough estimates, based on exports.

*o* Imports into United Kingdom from West and South Africa, extracted from board of trade returns by A. Sauerbeck, F. S. S.

*p* Imports of gold into Great Britain from China.

## WORLD'S PRODUCTION OF GOLD AND SILVER—Continued.

| COUNTRIES. | 1888. | | | | 1889. | | | |
|---|---|---|---|---|---|---|---|---|
| | Gold. | | Silver. | | Gold. | | Silver. | |
| | Kilograms. | Dollars. | Kilograms. | Dollars. | Kilograms. | Dollars. | Kilograms. | Dollars. |
| Total | 165, 809 | 110, 196, 915 | 3, 385, 606 | 140, 706, 413 | 182, 021 | 120, 971, 514 | 3, 820, 002 | 158, 759, 468 |
| United States | 49, 917 | 33, 175, 000 | 1, 424, 326 | 59, 195, 000 | 49, 353 | 32, 800, 000 | 1, 555, 486 | 64, 646, 000 |
| Australasia | 42, 974 | 28, 560, 660 | 120, 308 | *a*5, 000, 000 | 49, 784 | 33, 086, 700 | 144, 369 | *a*6, 000, 000 |
| Mexico | 1, 465 | 974, 000 | 995, 500 | 41, 373, 000 | 1, 053 | 700, 000 | 1, 335, 828 | 55, 517, 000 |
| European countries: | | | | | | | | |
| Russia | 32, 052 | 21, 302, 000 | 14, 523 | 604, 000 | 34, 867 | 23, 173, 000 | 14, 389 | 598, 000 |
| Germany | 1, 792 | 1, 190, 963 | 32, 051 | 1, 332, 022 | 1, 958 | 1, 301, 286 | 32, 040 | 1, 331, 576 |
| Austria-Hungary | 1, 820 | 1, 209, 572 | 52, 128 | 2, 166, 440 | 2, 198 | 1, 461, 000 | 52, 651 | 2, 188, 000 |
| Sweden | 76 | 50, 000 | 4, 648 | 193, 000 | 74 | 48, 900 | 4, 267 | 177, 400 |
| Norway | ... | ... | 5, 147 | 214, 000 | ... | ... | 5, 147 | 214, 000 |
| Italy | 148 | 98, 000 | 35 | 1, 454 | *b*148 | 98, 000 | *b*35 | 1, 454 |
| Spain | ... | ... | 51, 502 | 2, 140, 400 | ... | ... | *b*51, 502 | 2, 140, 400 |
| Turkey | *c*10 | 7, 000 | *c*1, 323 | 55, 000 | 10 | 7, 000 | *c*1, 323 | 55, 000 |
| France | ... | ... | 49, 396 | 2, 053, 000 | ... | ... | *b*49, 396 | 2, 053, 000 |
| Great Britain | 220 | 146, 000 | 9, 047 | 376, 000 | 97 | 64, 370 | 9, 522 | 395, 734 |
| Dominion of Canada | 1, 673 | 1, 111, 959 | 9, 264 | 385, 000 | 1, 919 | 1, 275, 045 | *b*9, 264 | 385, 000 |
| South American countries: | | | | | | | | |
| Argentine Republic | 47 | 31, 000 | 10, 226 | 425, 000 | *b*47 | 31, 000 | *b*10, 226 | 425, 000 |
| Colombia | 4, 514 | 3, 000, 000 | 24, 061 | 1, 000, 000 | 3, 762 | 2, 500, 000 | 31, 280 | 1, 300, 000 |
| Bolivia | 90 | 59, 800 | 230, 460 | 9, 578, 000 | *b*90 | 59, 800 | *b*230, 460 | 9, 578, 000 |
| Chile | 2, 953 | 1, 962, 430 | 185, 851 | 7, 723, 957 | 2, 162 | 1, 436, 600 | 123, 695 | 5, 140, 764 |
| Brazil | 670 | 445, 300 | ... | ... | 670 | *b*445, 300 | ... | ... |
| Venezuela | 2, 130 | 1, 415, 598 | ... | ... | 2, 765 | 1, 838, 000 | ... | ... |
| Guiana (British) | 450 | 299, 070 | ... | ... | 882 | 586, 177 | ... | ... |
| Guiana (Dutch) | 487 | *d*324, 000 | ... | ... | 487 | 324, 000 | ... | ... |
| Peru | 158 | 105, 000 | 75, 263 | 3, 128, 000 | 140 | 93, 044 | 68, 575 | 2, 850, 000 |
| Central American states | 226 | *e*150, 000 | 48, 123 | *e*2, 000, 000 | 226 | *e*150, 000 | 48, 123 | *e*2, 000, 000 |
| Japan | *f*606 | 403, 000 | *f*42, 424 | 1, 763, 140 | *f*606 | 403, 000 | *f*42, 424 | 1, 763, 140 |
| Africa | 6, 771 | 4, 500, 000 | ... | ... | 12, 920 | 8, 586, 632 | ... | ... |
| China | *g*13, 542 | 9, 000, 000 | ... | ... | 13, 542 | *b*9, 000, 000 | ... | ... |
| India (British) | 1, 018 | 676, 563 | ... | ... | 2, 261 | 1, 502, 660 | ... | ... |

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*a* Estimate of the bureau of the mint.
*b* Estimated the same as officially communicated for 1888.
*c* Estimated the same as officially communicated for 1886.
*d* "Jaarcijifers over 1888 en Vorige Jaaren", No. 8, page 115.
*e* Rough estimates, based on exports.
*f* Product of private mines in 1888; government mines in 1889.
*g* Imports of gold into Great Britain and British India from China.

## ESTIMATED GOLD AND SILVER PRODUCTION OF THE WORLD, 1852 TO 1885.(*a*)

[Values in millions of dollars.]

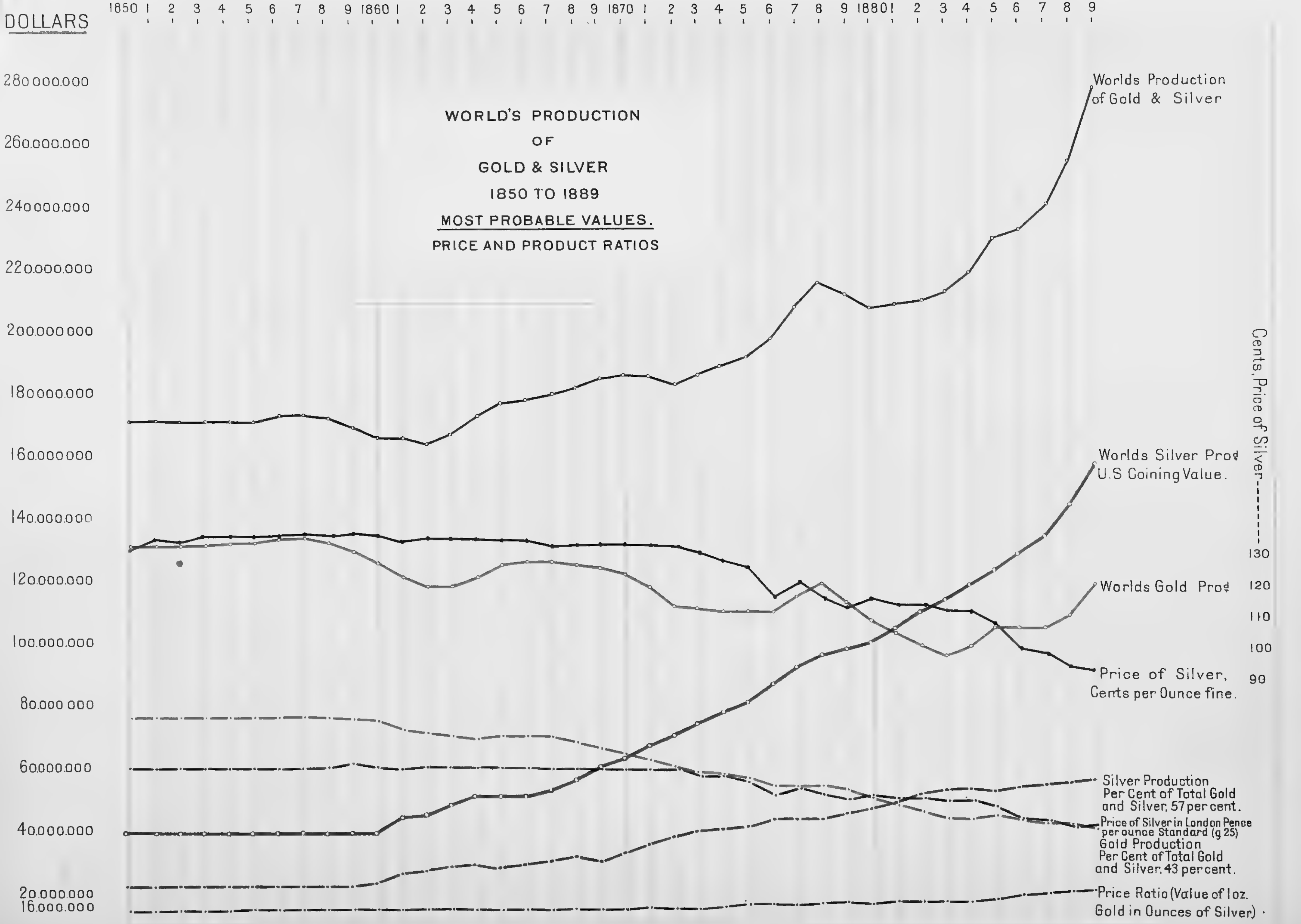
| GOLD PRODUCTION. | | | | | | | SILVER PRODUCTION. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Years. | Total. | Australasia. | United States. | Mexico and South America. | Russia. | Other countries. | Years | Total. | United States. | Mexico and South America. | Germany. | Other countries. |
| 1852 | 182.5 | 103.0 | 60.0 | 5.0 | 12.0 | 2.5 | 1852 | 40.5 | ........ | 30.0 | 2.0 | 8.5 |
| 1853 | 155.0 | 70.5 | 65.0 | 5.0 | 12.0 | 2.5 | 1853 | 40.5 | ........ | 30.0 | 2.0 | 8.5 |
| 1854 | 127.0 | 47.5 | 60.0 | 5.0 | 12.0 | 2.5 | 1854 | 40.5 | ........ | 30.0 | 2.0 | 8.5 |
| 1855 | 135.0 | 60.5 | 55.0 | 5.0 | 12.0 | 2.5 | 1855 | 40.5 | ........ | 30.0 | 2.0 | 8.5 |
| 1856 | 147.5 | 71.5 | 55.0 | 5.0 | 13.5 | 2.5 | 1856 | 41.0 | ........ | 30.0 | 2.5 | 8.5 |
| 1857 | 133.0 | 57.0 | 55.0 | 5.0 | 13.5 | 2.5 | 1857 | 41.0 | ........ | 30.0 | 2.5 | 8.5 |
| 1858 | 124.0 | 53.5 | 50.0 | 4.5 | 13.5 | 2.5 | 1858 | 41.0 | ........ | 30.0 | 2.5 | 8.5 |
| 1859 | 124.5 | 54.0 | 50.0 | 4.5 | 13.5 | 2.5 | 1859 | 40.5 | ........ | 30.0 | 2.5 | 8.0 |
| 1860 | 119.0 | 52.5 | 46.0 | 4.5 | 13.5 | 2.5 | 1860 | 41.0 | ........ | 30.0 | 3.0 | 8.0 |
| 1861 | 114.0 | 49.0 | 43.0 | 4.5 | 15.0 | 2.5 | 1861 | 43.0 | 2.0 | 30.0 | 3.0 | 8.0 |
| 1862 | 107.0 | 46.5 | 39.0 | 4.0 | 15.0 | 2.5 | 1862 | 45.5 | 4.5 | 30.0 | 3.0 | 8.0 |
| 1863 | 106.5 | 44.5 | 40.0 | 4.0 | 15.5 | 2.5 | 1863 | 49.5 | 8.5 | 30.0 | 3.0 | 8.0 |
| 1864 | 113.0 | 45.5 | 46.0 | 4.0 | 15.0 | 2.5 | 1864 | 52.0 | 11.0 | 30.0 | 3.0 | 8.0 |
| 1865 | 120.0 | 44.0 | 53.0 | 4.0 | 16.5 | 2.5 | 1865 | 52.5 | 11.5 | 30.0 | 3.0 | 8.0 |
| 1866 | 118.5 | 41.5 | 53.5 | 4.0 | 17.0 | 2.5 | 1866 | 52.0 | 10.0 | 30.0 | 4.0 | 8.0 |
| 1867 | 116.0 | 41.5 | 51.5 | 3.5 | 17.0 | 2.5 | 1867 | 50.5 | 13.5 | 25.0 | 4.0 | 8.0 |
| 1868 | 119.0 | 47.5 | 48.0 | 3.0 | 18.0 | 2.5 | 1868 | 49.0 | 12.0 | 25.0 | 4.0 | 8.0 |
| 1869 | 121.0 | 46.5 | 49.5 | 2.5 | 20.0 | 2.5 | 1869 | 49.0 | 12.0 | 25.0 | 4.0 | 8.0 |
| 1870 | 119.0 | 38.5 | 53.0 | 2.5 | 22.5 | 2.5 | 1870 | 55.5 | 16.0 | 27.5 | 4.0 | 8.0 |
| 1871 | 116.5 | 48.0 | 37.0 | 5.0 | 24.0 | 2.5 | 1871 | 59.0 | 19.0 | 27.5 | 6.5 | 6.0 |
| 1872 | 110.0 | 39.0 | 40.5 | 5.0 | 23.0 | 2.5 | 1872 | 58.5 | 20.0 | 26.0 | 6.5 | 6.0 |
| 1873 | 111.5 | 40.0 | 41.5 | 5.0 | 22.5 | 2.5 | 1873 | 64.0 | 27.5 | 24.0 | 6.5 | 6.0 |
| 1874 | 107.5 | 36.5 | 41.0 | 5.0 | 22.5 | 2.5 | 1874 | 68.0 | 29.5 | 26.0 | 6.5 | 6.0 |
| 1875 | 110.5 | 37.5 | 42.5 | 5.0 | 22.5 | 3.0 | 1875 | 68.5 | 31.0 | 25.0 | 6.5 | 6.0 |
| 1876 | 111.5 | 36.0 | 45.0 | 5.0 | 22.5 | 3.0 | 1876 | 77.0 | 39.0 | 25.0 | 5.5 | 7.5 |
| 1877 | 117.0 | 33.5 | 47.5 | 6.0 | 27.0 | 3.0 | 1877 | 87.0 | 46.0 | 27.5 | 6.0 | 7.5 |
| 1878 | 110.5 | 32.5 | 40.0 | 7.5 | 27.0 | 3.5 | 1878 | 80.5 | 37.5 | 29.5 | 6.0 | 7.5 |
| 1879 | 104.0 | 31.0 | 34.0 | 7.5 | 27.5 | 4.0 | 1879 | 79.0 | 37.5 | 27.5 | 6.5 | 7.5 |
| 1880 | 106.0 | 32.5 | 35.0 | 7.5 | 27.0 | 4.0 | 1880 | 89.0 | 39.5 | 34.5 | 7.0 | 8.0 |
| 1881 | 103.0 | 33.5 | 33.0 | 8.0 | 24.0 | 4.5 | 1881 | 94.0 | 43.0 | 36.0 | 7.0 | 8.0 |
| 1882 | 101.0 | 32. | 31.5 | 8.5 | 23.5 | 5.0 | 1882 | 102.5 | 48.0 | 37.5 | 8.0 | 9.0 |
| 1883 | 98.0 | 29.0 | 30.5 | 8.5 | 25.0 | 5.0 | 1883 | 103.0 | 43.0 | 42.5 | 8.5 | 9.0 |
| 1884 | 95.5 | 29.5 | 27.5 | 8.5 | 25.0 | 5.0 | 1884 | 104.0 | 43.5 | 42.5 | 9.0 | 9.0 |
| 1885 | 97.5 | 30.0 | 29.0 | 8.5 | 25.0 | 5.0 | 1885 | 106.5 | 44.5 | 42.5 | 9.5 | 10.0 |

*a* From tables by Sir Hector Hay, "Report of British commission on relative changes of the precious metals", 1887.

## WORLD'S PRODUCTION OF GOLD AND SILVER, PRICE OF SILVER, AND RATIO OF GOLD TO SILVER.

A study of the table on the following page and the diagram of the world's annual production of gold and silver, and the price of silver from 1850 to 1889, shows that the world's gold production from 1850 to 1857 remained nearly constant at about $134,000,000; then decreased irregularly till 1883, reaching a minimum of $97,000,000; then increased irregularly to 1889, when the product was $120,000,000. The silver production remained nearly constant from 1850 to 1860 at about $40,000,000, increasing slowly to 1866 to $52,000,000; then increased steadily and rapidly to 1887, and still more rapidly in 1888 and 1889 to $159,000,000.

The ratio of total value of silver product (at United States coining value) to that of the total of both gold and silver remained nearly constant, about 24 per cent, until 1860, increasing irregularly to 30 per cent in 1867, then steadily to 57 per cent in 1889, becoming equal to gold, or 50 per cent, in 1881. The production of silver and the ratio of silver production to total of silver and gold thus both had a period of slow increase from 1860 to 1867, and then a rapid increase, beginning in 1867 and lasting to the present time. The price of silver remained nearly constant (at over 60 pence per ounce standard in London, equal to over $1.32 per ounce fine) until 1872, being unaffected either by the decrease in the gold production or by the increase in silver production. In 1872 the rapid decrease in gold production, which had taken place for 4 years previously, was arrested, and for the next 4 years the decrease was very slight, and in the 10 years following a considerable increase took place. At this time (1872) no change took place in the rate of increase of silver production, this rate being nearly the same from 1867 to 1877; yet in 1873 began the decrease in price of silver, which has continued with but slight fluctuations to the present time. During the 23 years (1850 to 1872) the whole extent of the variation in price was only between $1.36 and $1.32 per ounce, or 3.8 cents, while in the 17 years, 1872 to 1889, inclusive, it declined from $1.322 to $0.936, or 38.6 cents, or over 29 per cent.



WORLD'S PRODUCTION
OF
GOLD & SILVER
1850 TO 1889
MOST PROBABLE VALUES.
PRICE AND PRODUCT RATIOS

### MOST PROBABLE VALUES OF THE WORLD'S PRODUCTION OF GOLD AND SILVER, PRICE OF SILVER, AND RATIO OF GOLD TO SILVER.

| YEARS. | PRODUCTION. (a) (Value in millions of dollars.) | | | PERCENTAGE OF TOTAL. | | Price of silver in London. (Pence per ounce standard.) | Value of silver per fine ounce. | Price ratio 1 ounce gold. (Ounces silver.) |
|---|---|---|---|---|---|---|---|---|
| | Total gold and silver. | United States coining value. | | Gold. | Silver. | | | |
| | | Gold. | Silver. | | | | | |
| 1850 to 1855 | 172 | 132 | 40 | 76.7 | 23.3 | 61.250 | $1.337 | 15.42 |
| 1856 | 174 | 134 | 40 | 77.0 | 23.0 | 61.313 | 1.344 | 15.34 |
| 1857 | 174 | 134 | 40 | 77.0 | 23.0 | 61.750 | 1.353 | 15.27 |
| 1858 | 173 | 133 | 40 | 76.9 | 23.1 | 61.313 | 1.344 | 15.36 |
| 1859 | 170 | 130 | 40 | 76.5 | 23.5 | 62.063 | 1.360 | 15.21 |
| 1860 | 167 | 127 | 40 | 76.0 | 24.0 | 61.688 | 1.352 | 15.30 |
| 1861 | 167 | 122 | 45 | 73.1 | 26.9 | 60.813 | 1.333 | 15.48 |
| 1862 | 165 | 119 | 46 | 72.1 | 27.9 | 61.438 | 1.346 | 15.36 |
| 1863 | 168 | 119 | 49 | 70.8 | 29.2 | 61.375 | 1.345 | 15.38 |
| 1864 | 174 | 122 | 52 | 70.1 | 29.9 | 61.375 | 1.345 | 15.39 |
| 1865 | 178 | 126 | 52 | 70.8 | 29.2 | 61.063 | 1.338 | 15.43 |
| 1866 | 179 | 127 | 52 | 70.9 | 29.1 | 61.125 | 1.339 | 15.44 |
| 1867 | 181 | 127 | 54 | 70.2 | 29.8 | 60.563 | 1.328 | 15.57 |
| 1868 | 183 | 126 | 57 | 68.9 | 31.1 | 60.500 | 1.326 | 15.61 |
| 1869 | 186 | 125 | 61 | 67.2 | 32.8 | 60.438 | 1.325 | 15.60 |
| 1870 | 187 | 123 | 64 | 65.8 | 34.2 | 60.563 | 1.328 | 15.60 |
| 1871 | 187 | 119 | 68 | 63.6 | 36.4 | 60.500 | 1.326 | 15.58 |
| 1872 | 184 | 113 | 71 | 61.4 | 38.6 | 60.313 | 1.322 | 15.64 |
| 1873 | 187 | 112 | 75 | 59.9 | 40.1 | 59.250 | 1.298 | 15.93 |
| 1874 | 190 | 111 | 79 | 58.4 | 41.6 | 58.313 | 1.278 | 16.16 |
| 1875 | 193 | 111 | 82 | 57.5 | 42.5 | 56.875 | 1.246 | 16.63 |
| 1876 | 199 | 111 | 88 | 55.8 | 44.2 | 52.750 | 1.156 | 17.80 |
| 1877 | 200 | 116 | 93 | 55.5 | 44.5 | 54.813 | 1.201 | 17.19 |
| 1878 | 217 | 120 | 97 | 55.3 | 44.7 | 52.563 | 1.152 | 17.96 |
| 1879 | 213 | 114 | 99 | 53.5 | 46.5 | 51.250 | 1.123 | 18.39 |
| 1880 | 209 | 108 | 101 | 51.7 | 48.3 | 52.250 | 1.145 | 18.06 |
| 1881 | 210 | 104 | 106 | 49.5 | 50.5 | 51.938 | 1.138 | 18.24 |
| 1882 | 211 | 100 | 111 | 47.4 | 52.6 | 51.813 | 1.136 | 18.27 |
| 1883 | 212 | 97 | 115 | 45.8 | 54.2 | 50.625 | 1.110 | 18.65 |
| 1884 | 220 | 100 | 120 | 45.5 | 54.5 | 50.750 | 1.113 | 18.63 |
| 1885 | 231 | 106 | 125 | 45.9 | 54.1 | 48.563 | 1.065 | 19.39 |
| 1886 | 236 | 106 | 130 | 44.9 | 55.1 | 45.375 | 0.995 | 20.78 |
| 1887 | 242 | 106 | 136 | 43.8 | 56.2 | 44.625 | 0.978 | 21.13 |
| 1888 | 256 | 110 | 146 | 43.0 | 57.0 | 42.875 | 0.940 | 21.99 |
| 1889 | 279 | 120 | 159 | 43.0 | 57.0 | 42.688 | 0.936 | 22.09 |

*a* The figures of production are the "most probable values" arrived at from a comparison of the tables of Soetbeer, the director of the mint, and Sir Hector Hay. The price of silver is taken from the report of the director of the mint for 1889. The price ratio is from Soetbeer's tables down to 1885, and from 1886 to 1889 is calculated from the London price.

The diagram does not reveal the cause of the decline in the price of silver, for if it be assumed that the ratio of the production of silver to that of gold controls the price of the former, then the decrease in the price should have begun in 1860, when the ratio of silver product began to increase, and the decrease would have been more pronounced in 1867, when the silver product increased more rapidly and the gold production decreased.

There is nothing in the figures or in the diagram to explain why the decline began in 1873 instead of in 1860 or 1867.

A study of Soetbeer's figures for 380 years, from 1493 to 1873, will also show no relation between the relative production of gold and silver, and from 1800 to 1870, although the value of the product of the two metals varied from 3.227 silver to 1 of gold down to 0.44 silver to 1 of gold, the relative price varied only between 15.41 and 15.83 to 1. From the year 1873 to the present time, however, there appears to be a very close agreement between the product ratio and the price ratio, as shown by the coincidence between the curves on the diagram representing "gold production, per cent of total gold and silver", and price of silver in pence in London. Thus, in 1873 the total value of the gold product, expressed as a percentage of the total of the gold and silver, was 59.9, and in 1889 it was 43; the price of silver in London in 1873 was 59.25 pence, and in 1889 42.69 pence.

Of the possible causes of the phenomenon of the steadiness in price of silver until 1873 and the steady decline since that time many explanations are given in the report of the British commission on the recent changes in the relative values of the precious metals. The cause which seems to have most weight in the opinion of all the members of the committee is the cessation in 1873 of the free coinage of silver in Germany, Holland, and the Latin

Union, comprising France, Belgium, Italy, Switzerland, and Greece. In the conclusion of their report, approved by all the members of the commission, they say:

> We are of the opinion that the true explanation of the phenomena which we are directed to investigate is to be found in a combination of causes, and can not be attributed to any one cause alone. The action of the Latin Union in 1873 broke the link between gold and silver, which had kept the price of the former, as measured by the latter, constant at above the legal ratio, and when this link was broken the silver market was open to the influence of all the factors which go to affect the price of a commodity. These factors happen since 1873 to have operated in the direction of a fall in the gold price of that metal.

Mr. George F. Becker, United States geologist, in a paper on the "Relative production and relative value of the precious metals", printed in Mr. Edward Atkinson's report on bimetallism, gives a table and diagram showing that the relative product and the relative value of gold and silver bore no relation to each other between 1493 and 1873, but that since 1873 the two ratios have been closely connected. He explains the difference between the periods before and after 1873 as follows:

> The statement that the value of silver relatively to gold remained substantially constant for over 200 years at about 1 to 15.5 is equivalent to the statement that in such quantities as silver bullion was offered to buyers it found a market at that price, and that silver coin was always exchangeable for gold at the same figures.
>
> This stability in the price of silver could be maintained only so long as the quantity of circulating medium demanded by trade, added to the inevitable losses and waste of the metals and to the quantity urgently demanded at the standard price or above it for industrial consumption and for permanent exportation to semicivilized countries, equaled or exceeded the available supply. It is clear that this state of things is compatible only with a moderate production, for the moment that more of either metal was put on the market than could be absorbed in these ways it would be more profitable to the producers to submit to a discount than to hold their bullion.
>
> Great fluctuations in the ratio of the gold product to the silver product can thus occur without necessarily affecting the price of silver to a considerable extent so long as the total product of the precious metals does not exceed the demand of the commercial world for coin plus the demand for these metals at coining rates for nonmonetary application.
>
> It is certain that prior to 1873 the coinage laws fixed the price of silver and that the national treasuries were able to control the market for silver, for in no other way could considerable fluctuations have been avoided. It is also certain that in 1873 the laws ceased to determine the price, as if there were an excess of silver in the market, and that since that time the price of silver has been chiefly determined by the ratio of the production of silver to that of gold, as it would be if either of the two metals were produced in excess. The analysis of Dr. Soetbeer and the coinage statistics also show that a diminishing proportion of the yield of each metal is added to the available stock of coin. All of these facts point to the conclusion that the supply of silver is now greater than the demand for it at coining rates.

## THE RELATION OF THE PRICE OF SILVER TO THE PRICE OF COMMODITIES.

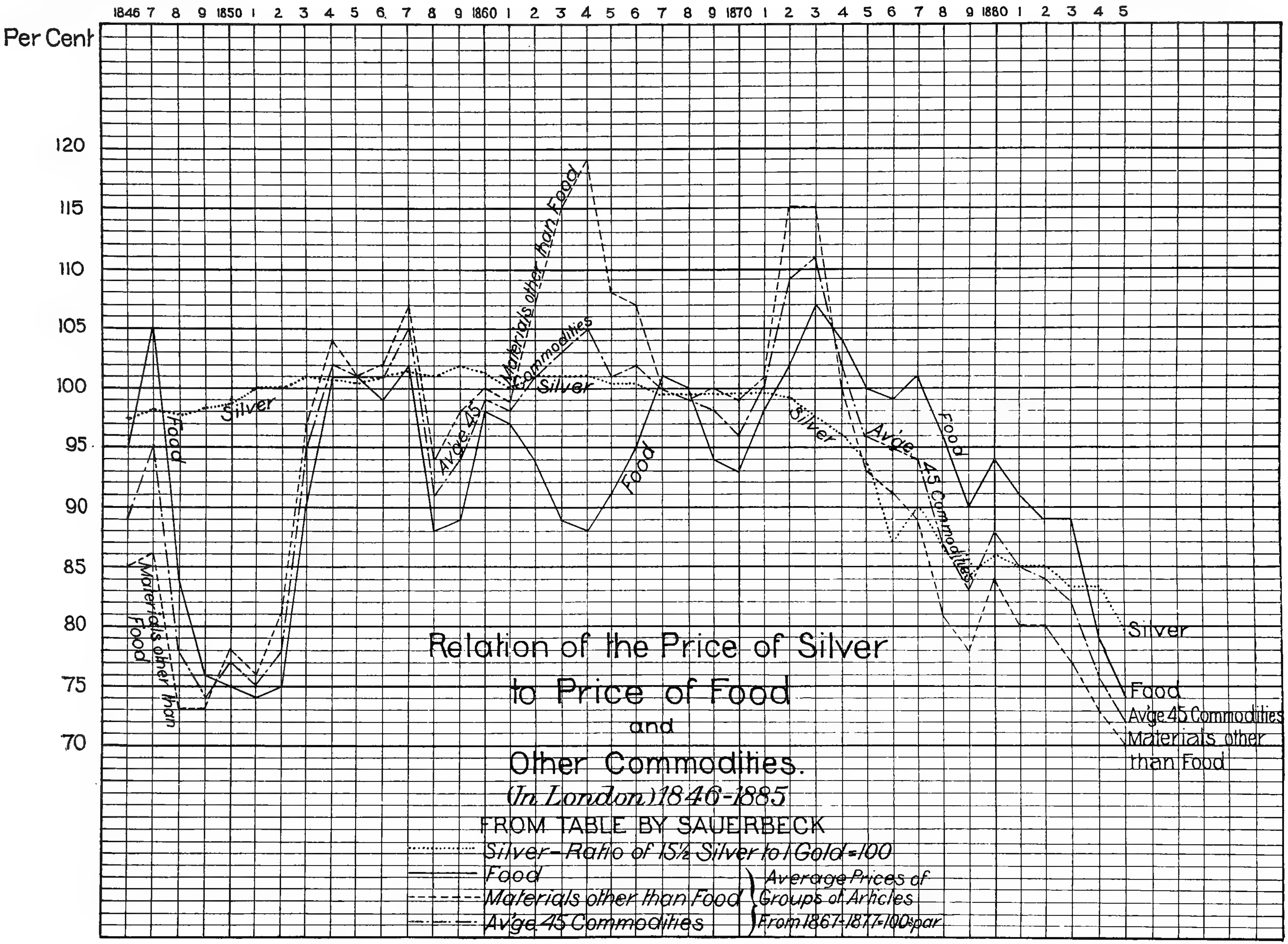
In the discussion of the relative product and the relative price of gold and silver, it has been shown that prior to 1873 the price of silver was not controlled by the ratio of the product of the two metals, but that since 1873 the price of silver appears to be, if not controlled, at least strongly influenced by the ratio which the product of silver bears to the total product of both gold and silver.

Prior to 1873 the price of silver in gold, or the ratio of gold to silver, remained nearly constant for 200 years, the two metals being maintained at a level by the coinage laws of the leading civilized nations; but since 1873, when free coinage of silver ceased, silver became a commodity, and its price thereafter fluctuated in the same manner as other commodities. The relation of the price of silver to the price of other commodities is clearly shown in a table presented by Mr. Augustus Sauerbeck to the British commission on "Recent changes in the relative value of the precious metals" (first report, page 317), giving the "index numbers" from 1846 to 1885 of the prices (in London) of 45 commodities, including vegetable food, animal food, sugar, coffee and tea, minerals, textiles, and sundry materials, and of the prices of silver. The table following is summarized from the table of Mr. Sauerbeck, giving his principal divisions of food, total materials other than food, total of 45 commodities, and silver. The figures for silver are the percentage values as compared with silver at 60.84 pence per ounce, being the parity between gold and silver at 1 to 15.5. The index numbers for the other commodities are percentages compared with the average prices for the years 1867 to 1877.

The accompanying diagram, plotted from the table, shows that the price of silver remained practically constant between 1846 and 1873, fluctuating only between 97.4 and 102 per cent of the par ratio of 15.5 to 1, while the price of commodities fluctuated violently, the index number for the total of 45 commodities falling from 95 in 1847 to 74 in 1849, rising from 75 in 1851 to 102 in 1854 and to 105 in 1857, dropping to 94 in 1859 and rising to 105 in 1864, dropping slowly to 96 in 1870 and rising to 111 in 1873. The index numbers of food and of materials other than food follow quite closely the figures representing the total of 45 commodities, except during the years 1861 to 1867, including the period of the American war. During this period the index numbers of food were as low as 88 (in 1864), while at the same date the index number of materials other than food rose to 119. After 1867 the index numbers of food and of materials again showed a correspondence.

Since 1873 there has been a steady downward tendency of the prices of both food and material, the price index numbers of food, however, being higher than those of materials, the index numbers of the 45 commodities falling nearly midway between those of food and of materials.

The relative price of silver as compared with the par ratio of 15.5 to 1 follows the index numbers of the 45 commodities quite closely, showing that since 1873 silver has become a commodity and is subject to the same laws of fluctuation of price as other commodities.



Relation of the Price of Silver to Price of Food and Other Commodities. (In London) 1846-1885

FROM TABLE BY SAUERBECK

### MR. A. SAUERBECK'S INDEX NUMBERS COMPARED WITH RATIO OF SILVER AND GOLD.

[Average price of groups of articles from 1867 to 1877.]

| YEARS. | INDEX NUMBERS. | | | | YEARS. | INDEX NUMBERS. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Food. | Materials. | Total 45 commodities. | Silver. (*a*) | | Food. | Materials. | Total 45 commodities. | Silver. (*a*) |
| 1846 | 95 | 85 | 89 | 97.5 | 1866 | 95 | 107 | 102 | 100.5 |
| 1847 | 105 | 86 | 95 | 98.1 | 1867 | 101 | 100 | 100 | 99.7 |
| 1848 | 84 | 73 | 78 | 97.8 | 1868 | 100 | 99 | 99 | 99.6 |
| 1849 | 76 | 73 | 74 | 98.2 | 1869 | 94 | 100 | 98 | 99.6 |
| 1850 | 75 | 78 | 77 | 98.7 | 1870 | 93 | 99 | 96 | 99.6 |
| 1851 | 74 | 76 | 75 | 99.9 | 1871 | 98 | 101 | 100 | 99.7 |
| 1852 | 75 | 81 | 78 | 99.9 | 1872 | 102 | 115 | 109 | 99.2 |
| 1853 | 91 | 97 | 95 | 101.2 | 1873 | 107 | 114 | 111 | 97.4 |
| 1854 | 101 | 104 | 102 | 101.1 | 1874 | 104 | 100 | 102 | 95.8 |
| 1855 | 101 | 101 | 101 | 100.7 | 1875 | 100 | 93 | 96 | 93.3 |
| 1856 | 99 | 102 | 101 | 101.0 | 1876 | 99 | 91 | 95 | 86.7 |
| 1857 | 102 | 107 | 105 | 101.5 | 1877 | 101 | 89 | 94 | 90.2 |
| 1858 | 88 | 94 | 91 | 101.0 | 1878 | 98 | 81 | 87 | 86.4 |
| 1859 | 89 | 98 | 94 | 102.0 | 1879 | 90 | 78 | 83 | 84.2 |
| 1860 | 98 | 100 | 99 | 101.4 | 1880 | 94 | 84 | 88 | 85.9 |
| 1861 | 97 | 99 | 98 | 99.9 | 1881 | 91 | 80 | 85 | 85.0 |
| 1862 | 94 | 107 | 101 | 100.9 | 1882 | 89 | 80 | 84 | 84.9 |
| 1863 | 89 | 115 | 103 | 101.1 | 1883 | 89 | 77 | 82 | 83.1 |
| 1864 | 88 | 119 | 105 | 100.9 | 1884 | 79 | 73 | 76 | 83.3 |
| 1865 | 91 | 108 | 101 | 100.3 | 1885 | 74 | 70 | 72 | 79.9 |

*a* The figures under "Silver" represent the price of silver as compared with 60.84 pence per ounce, being the parity between gold and silver at the ratio of 1 to 15.5.

To complete the statistics of the market values of the precious metals, the following tables, taken from the report of the director of the United States mint, are given to show the commercial ratio of silver to gold each year since 1687, and the highest, lowest, and average price of bar silver in London per ounce, British standard (0.925), since 1833, and the equivalent in United States gold coin of an ounce 1,000 fine, taken at the average price:

### COMMERCIAL RATIO OF SILVER TO GOLD EACH YEAR SINCE 1687.

[From 1687 to 1832 the ratios are taken from Dr. A. Soetbeer; from 1833 to 1878 from Pixley and Abell's tables, and from 1879 to 1889 from daily cablegrams from London to the bureau of the mint.]

| YEARS. | Ratio. | YEARS. | Ratio. | YEARS. | Ratio. | YEARS. | Ratio. | YEARS. | Ratio. | YEARS. | Ratio. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1687 | 14.94 | 1721 | 15.05 | 1755 | 14.68 | 1789 | 14.75 | 1823 | 15.84 | 1857 | 15.27 |
| 1688 | 14.94 | 1722 | 15.17 | 1756 | 14.94 | 1790 | 15.04 | 1824 | 15.82 | 1858 | 15.38 |
| 1689 | 15.02 | 1723 | 15.20 | 1757 | 14.87 | 1791 | 15.05 | 1825 | 15.70 | 1859 | 15.19 |
| 1690 | 15.02 | 1724 | 15.11 | 1758 | 14.85 | 1792 | 15.17 | 1826 | 15.76 | 1860 | 15.29 |
| 1691 | 14.98 | 1725 | 15.11 | 1759 | 14.15 | 1793 | 15.00 | 1827 | 15.74 | 1861 | 15.50 |
| 1692 | 14.92 | 1726 | 15.15 | 1760 | 14.14 | 1794 | 15.37 | 1828 | 15.78 | 1862 | 15.35 |
| 1693 | 14.83 | 1727 | 15.24 | 1761 | 14.54 | 1795 | 15.55 | 1829 | 15.78 | 1863 | 15.37 |
| 1694 | 14.87 | 1728 | 15.11 | 1762 | 15.27 | 1796 | 15.65 | 1830 | 15.82 | 1864 | 15.37 |
| 1695 | 15.02 | 1729 | 14.92 | 1763 | 14.99 | 1797 | 15.41 | 1831 | 15.72 | 1865 | 15.44 |
| 1696 | 15.00 | 1730 | 14.81 | 1764 | 14.70 | 1798 | 15.59 | 1832 | 15.73 | 1866 | 15.43 |
| 1697 | 15.20 | 1731 | 14.94 | 1765 | 14.83 | 1799 | 15.74 | 1833 | 15.93 | 1867 | 15.57 |
| 1698 | 15.07 | 1732 | 15.09 | 1766 | 14.80 | 1800 | 15.68 | 1834 | 15.73 | 1868 | 15.59 |
| 1699 | 14.94 | 1733 | 15.18 | 1767 | 14.85 | 1801 | 15.46 | 1835 | 15.80 | 1869 | 15.60 |
| 1700 | 14.81 | 1734 | 15.39 | 1768 | 14.80 | 1802 | 15.26 | 1836 | 15.72 | 1870 | 15.57 |
| 1701 | 15.07 | 1735 | 15.41 | 1769 | 14.72 | 1803 | 15.41 | 1837 | 15.83 | 1871 | 15.57 |
| 1702 | 15.52 | 1736 | 15.18 | 1770 | 14.62 | 1804 | 15.41 | 1838 | 15.85 | 1872 | 15.63 |
| 1703 | 15.17 | 1737 | 15.02 | 1771 | 14.66 | 1805 | 15.79 | 1839 | 15.62 | 1873 | 15.92 |
| 1704 | 15.22 | 1738 | 14.91 | 1772 | 14.52 | 1806 | 15.52 | 1840 | 15.62 | 1874 | 16.17 |
| 1705 | 15.11 | 1739 | 14.91 | 1773 | 14.62 | 1807 | 15.43 | 1841 | 15.70 | 1875 | 16.59 |
| 1706 | 15.27 | 1740 | 14.94 | 1774 | 14.62 | 1808 | 16.08 | 1842 | 15.87 | 1876 | 17.88 |
| 1707 | 15.44 | 1741 | 14.92 | 1775 | 14.72 | 1809 | 15.96 | 1843 | 15.93 | 1877 | 17.22 |
| 1708 | 15.41 | 1742 | 14.85 | 1776 | 14.55 | 1810 | 15.77 | 1844 | 15.85 | 1878 | 17.94 |
| 1709 | 15.31 | 1743 | 14.85 | 1777 | 14.54 | 1811 | 15.53 | 1845 | 15.92 | 1879 | 18.40 |
| 1710 | 15.22 | 1744 | 14.87 | 1778 | 14.68 | 1812 | 16.11 | 1846 | 15.90 | 1880 | 18.05 |
| 1711 | 15.29 | 1745 | 14.98 | 1779 | 14.80 | 1813 | 16.25 | 1847 | 15.80 | 1881 | 18.16 |
| 1712 | 15.31 | 1746 | 15.13 | 1780 | 14.72 | 1814 | 15.04 | 1848 | 15.85 | 1882 | 18.19 |
| 1713 | 15.24 | 1747 | 15.26 | 1781 | 14.78 | 1815 | 15.26 | 1849 | 15.78 | 1883 | 18.64 |
| 1714 | 15.13 | 1748 | 15.11 | 1782 | 14.42 | 1816 | 15.28 | 1850 | 15.70 | 1884 | 18.57 |
| 1715 | 15.11 | 1749 | 14.80 | 1783 | 14.48 | 1817 | 15.11 | 1851 | 15.46 | 1885 | 19.41 |
| 1716 | 15.09 | 1750 | 14.55 | 1784 | 14.70 | 1818 | 15.35 | 1852 | 15.59 | 1886 | 20.78 |
| 1717 | 15.13 | 1751 | 14.39 | 1785 | 14.92 | 1819 | 15.33 | 1853 | 15.33 | 1887 | 21.13 |
| 1718 | 15.11 | 1752 | 14.54 | 1786 | 14.96 | 1820 | 15.62 | 1854 | 15.33 | 1888 | 21.99 |
| 1719 | 15.09 | 1753 | 14.54 | 1787 | 14.92 | 1821 | 15.95 | 1855 | 15.38 | 1889 | 22.09 |
| 1720 | 15.04 | 1754 | 14.48 | 1788 | 14.65 | 1822 | 15.80 | 1856 | 15.38 | | |

### HIGHEST, LOWEST, AND AVERAGE PRICE OF BAR SILVER IN LONDON.

[Per ounce, British standard (0.925), since 1833, and the equivalent in United States gold coin of an ounce 1,000 fine, taken at the average price.]

| CALENDAR YEARS. | Lowest quotation. (Pence.) | Highest quotation. (Pence.) | Average quotation. (Pence.) | Value of a fine ounce at average quotation. |
|---|---|---|---|---|
| 1833 | 58.750 | 59.875 | 59.188 | $1.297 |
| 1834 | 59.750 | 60.750 | 59.938 | 1.313 |
| 1835 | 59.250 | 60.000 | 59.688 | 1.308 |
| 1836 | 59.625 | 60.375 | 60.000 | 1.315 |
| 1837 | 59.000 | 60.375 | 59.563 | 1.305 |
| 1838 | 59.500 | 60.125 | 59.500 | 1.304 |
| 1839 | 60.000 | 60.625 | 60.375 | 1.323 |
| 1840 | 60.125 | 60.750 | 60.375 | 1.323 |
| 1841 | 59.750 | 60.375 | 60.063 | 1.316 |
| 1842 | 59.250 | 60.000 | 59.438 | 1.303 |
| 1843 | 59.000 | 59.625 | 59.188 | 1.297 |
| 1844 | 59.250 | 59.750 | 59.500 | 1.304 |
| 1845 | 58.875 | 59.875 | 59.250 | 1.298 |
| 1846 | 59.000 | 60.125 | 59.313 | 1.300 |
| 1847 | 58.875 | 60.375 | 59.688 | 1.308 |
| 1848 | 58.500 | 60.000 | 59.500 | 1.304 |
| 1849 | 59.500 | 60.000 | 59.750 | 1.309 |
| 1850 | 59.500 | 61.500 | 61.063 | 1.316 |
| 1851 | 60.000 | 61.625 | 61.000 | 1.337 |
| 1852 | 59.875 | 61.875 | 60.500 | 1.326 |
| 1853 | 60.625 | 61.875 | 61.500 | 1.348 |
| 1854 | 60.875 | 61.875 | 61.500 | 1.348 |
| 1855 | 60.000 | 61.625 | 61.313 | 1.344 |
| 1856 | 60.500 | 62.250 | 61.313 | 1.344 |
| 1857 | 61.000 | 62.375 | 61.750 | 1.353 |
| 1858 | 60.750 | 61.875 | 61.313 | 1.344 |
| 1859 | 61.750 | 62.750 | 62.063 | 1.360 |
| 1860 | 61.250 | 62.375 | 61.688 | 1.352 |
| 1861 | 60.125 | 61.375 | 60.813 | 1.333 |
| 1862 | 61.000 | 62.125 | 61.438 | $1.346 |
| 1863 | 61.000 | 61.750 | 61.375 | 1.345 |
| 1864 | 60.625 | 62.500 | 61.375 | 1.345 |
| 1865 | 60.500 | 61.625 | 61.063 | 1.338 |
| 1866 | 60.375 | 62.250 | 61.125 | 1.339 |
| 1867 | 60.375 | 61.250 | 60.563 | 1.328 |
| 1868 | 60.125 | 61.125 | 60.500 | 1.326 |
| 1869 | 60.000 | 61.000 | 60.438 | 1.325 |
| 1870 | 60.250 | 60.750 | 60.563 | 1.328 |
| 1871 | 60.188 | 61.000 | 60.500 | 1.326 |
| 1872 | 59.250 | 61.125 | 60.313 | 1.322 |
| 1873 | 57.875 | 59.938 | 59.250 | 1.298 |
| 1874 | 57.250 | 59.500 | 58.313 | 1.278 |
| 1875 | 55.500 | 57.625 | 56.875 | 1.246 |
| 1876 | 46.750 | 58.500 | 52.750 | 1.156 |
| 1877 | 53.250 | 58.250 | 54.813 | 1.201 |
| 1878 | 49.500 | 55.250 | 52.563 | 1.152 |
| 1879 | 48.875 | 53.750 | 51.250 | 1.123 |
| 1880 | 51.625 | 52.875 | 52.250 | 1.145 |
| 1881 | 50.875 | 52.875 | 51.938 | 1.138 |
| 1882 | 50.000 | 52.375 | 51.813 | 1.136 |
| 1883 | 50.000 | 51.188 | 50.625 | 1.110 |
| 1884 | 49.500 | 51.375 | 50.750 | 1.113 |
| 1885 | 46.875 | 50.000 | 48.563 | 1.065 |
| 1886 | 42.000 | 47.000 | 45.375 | 0.995 |
| 1887 | 43.250 | 47.125 | 44.625 | 0.978 |
| 1888 | 41.625 | 44.563 | 42.875 | 0.940 |
| 1889 | 42.000 | 44.375 | 42.688 | 0.936 |

## IMPORTS AND EXPORTS OF THE PRECIOUS METALS.

The collection of statistics of the imports and exports of the precious metals, their uses in coinage and in the arts, and the stock of precious metals in this and foreign countries, are subjects that come in the immediate department of the director of the mint, and from his admirable reports the following information has been condensed:

### GOLD.

The value of the foreign gold bullion imported into the United States during the calendar year 1889 was $1,679,999. Of this, $490,336 came from the British possessions in North America, $185,560 from Australasia, and the balance from South and Central American countries.

In addition to imports of foreign gold bullion, gold ores of the invoiced value of $56,888 were brought into this country for reduction, all except a small amount coming from Mexico and Colombia.

Foreign gold coins were imported of the value of $8,387,933, of which $3,767,392 were from Australasia, $1,459,861 from France, $1,630,073 from Germany, $370,828 from England, $318,832 from Mexico, $607,508 from Cuba, $141,247 from Colombia, and the remainder from various countries, principally of South America.

United States gold coins were imported during the year of the value of $1,936,700.

### GOLD IMPORTS IN 1889.

| | |
|---|---|
| Foreign bullion | $1,679,999 |
| Foreign coin | 8,387,933 |
| Foreign ores | 56,888 |
| Total foreign | 10,124,820 |
| United States coin | 1,936,700 |
| Total imports | 12,061,520 |

There was exported from the United States during the calendar year domestic gold bullion of the value of $40,518,521, of which $39,402,004 consisted of United States bars and $1,116,517 of other bars and bullion.

Of the gold bars exported, $27,692,855 went to France, $12,795,575 to England, $17,800 to Germany, and $12,291 to Hongkong.

Foreign gold bullion of the value of $12,600 was re-exported to England, and foreign gold ores of the value of $1,952 to Germany and England, while domestic gold and silver ores were exported of the value of $12,861, mostly to Germany.

Native gold coin was exported to the value of $4,784,976, of which $2,528,326 went to Venezuela, the remainder going to Hongkong, Hayti, San Domingo, the Hawaiian Islands, and other countries, principally of South and Central America, but a trifling amount going to Europe.

Foreign gold coins were re-exported of the value of $5,617,363, of which $4,367,312 went to Cuba, $886,307 to England, $258,790 to Brazil, and the remainder to various countries, principally of South America.

### GOLD EXPORTS IN 1889.

| | | |
|---|---:|---:|
| United States bars | | $39,402,004 |
| Other domestic bullion | | 1,116,517 |
| Domestic coin | | 4,784,976 |
| Domestic ores | | 12,861 |
| Total domestic | | 45,316,358 |
| Foreign bullion re-exported | $12,600 | |
| Foreign coin re-exported | 5,617,363 | |
| Foreign ores re-exported | 1,952 | |
| Total foreign | | 5,631,915 |
| Total gold exports | | 50,948,273 |

From the above totals it will be seen that there was a net loss of gold to the United States during the year by excess of exports over imports of the value of $38,886,753.

### SILVER.

The commercial value of the foreign silver bullion imported into the United States during the calendar year, as registered at the customhouses, was $5,453,534. This bullion consisted of unparted bars, the bulk of it, $4,636,174, coming from Mexico, $736,304 from Colombia, $16,623 from the British possessions in North America, and the remainder principally from states of Central America.

In addition to the imports of foreign silver bars, silver ores were imported into the United States for reduction of the invoiced value of $7,584,715. The bulk of these ores also came from Mexico, the invoiced value from that country being $7,381,513; $161,084 from the British possessions in North America, and the remainder principally from countries of South and Central America. Most of these ores were what are known as silver-lead ores, containing, in addition to silver, large quantities of metallic lead, with some little gold and copper.

### APPROXIMATE STATEMENT OF THE QUANTITIES AND VALUES OF SILVER ORES IMPORTED INTO THE UNITED STATES DURING THE CALENDAR YEAR 1889.

| CUSTOMS DISTRICTS. | Total ore. (Pounds.) | LEAD CONTAINED. | | COPPER CONTAINED. | | Commercial value of silver contained. | Value of gold contained. | Total value. |
|---|---:|---:|---:|---:|---:|---:|---:|---:|
| | | Quantity. (Pounds.) | Value. | Quantity. (Pounds.) | Value. | | | |
| Total | 241,494,307 | 53,166,802 | $1,001,473 | 280,573 | $14,273 | $6,722,086 | $59,406 | $7,797,238 |
| Boston and Charlestown, Massachusetts | | | | | | 2,000 | | 2,000 |
| Corpus Christi, Texas | 44,506,698 | 6,221,390 | 52,253 | | | 1,125,506 | 33,179 | 1,210,938 |
| Duluth, Minnesota | 28,800 | | | | | 7,800 | | 7,800 |
| Minnesota, Minnesota | 27,730 | | | | | 15,000 | | 15,000 |
| New Orleans, Louisiana | 1,076,764 | | | | | 42,161 | 5,800 | 47,961 |
| New York, New York | | 27,569 | | | | 497,685 | | 497,685 |
| Omaha, Nebraska | 33,644 | | | | | 1,750 | | 1,750 |
| Oswegatchie, New York | 161,540 | | | | | 118,230 | | 118,230 |
| Paso del Norte, Texas and New Mexico | 140,116,091 | 32,622,256 | 761,322 | 280,573 | 14,273 | 3,729,591 | 2,901 | 4,508,087 |
| Saluria, Texas | 55,543,040 | 14,295,587 | 187,898 | | | 626,644 | 17,526 | 832,068 |
| San Francisco, California | | | | | | 555,719 | | 555,719 |

Foreign silver coins were imported into the United States of the value of $13,579,782, of which $12,637,296 were Mexican dollars, the remainder coming from various countries, mainly South and Central America.

United States silver coins, principally subsidiary pieces, were imported of the value of $185,946.

The total imports of silver into the United States during the year may be recapitulated as follows:

### IMPORTS OF SILVER IN 1889.

| | |
|---|---|
| Foreign bullion (commercial value) | $5,453,534 |
| Silver in foreign ores (commercial value) | 6,722,086 |
| Foreign silver coin | 13,579,782 |
| Total foreign | 25,755,402 |
| United States silver coin (subsidiary) | 185,946 |
| Total silver imports | 25,941,348 |

There was exported from the United States during the calendar year domestic silver bullion of the commercial value of $27,068,531, of which $766,777 consisted of bars bearing the stamp of a United States mint or assay office, the remainder being bars of private refineries.

Of the silver bullion exported from the United States $18,092,735 went to London, $3,422,500 to Hongkong, $3,394,900 to Japan, $1,324,784 to the East Indies, $221,660 (for refining) to Germany, and the remainder principally to South and Central America.

Foreign silver bullion was re-exported of the value of $116,684, all going to London, and foreign silver ores of the value of $35,784, together with domestic gold and silver ores of the value of $12,861. Foreign silver coin was re-exported of the value of $13,385,867, most of which consisted of Mexican dollars, of which $9,281,871 went to Hongkong and $2,471,949 to London. United States silver coin of the value of $123,148 was exported. The exports of silver during the year may be recapitulated as follows:

### EXPORTS OF SILVER IN 1889.

| | | |
|---|---|---|
| United States bars (commercial value) | | $766,777 |
| Domestic bullion (commercial value) | | 26,301,754 |
| United States silver coin | | 123,148 |
| Total domestic | | 27,191,679 |
| Foreign silver coin, re-exported | $13,385,867 | |
| Silver, in foreign ores, re-exported | 35,784 | |
| Foreign silver bullion re-exported | 116,684 | |
| Total foreign | | 13,538,335 |
| Total silver exports | | 40,730,014 |

The above totals show that there was a net loss of silver to the United States during the year of $14,788,666.

## COINAGE DURING THE CALENDAR YEAR 1889.

The coinage executed during the calendar year 1889 at the 4 coinage mints, viz, at Philadelphia, San Francisco, New Orleans, and Carson City, aggregated 109,140,917 pieces, bearing the face value of $58,194,022.64.

### UNITED STATES COINAGE, CALENDAR YEAR 1889.

| DESCRIPTION. | Pieces. | Value. |
|---|---|---|
| Total | 109,140,917 | $58,194,022.64 |
| Gold | 1,338,012 | 21,413,931.00 |
| Silver dollars | 34,651,811 | 34,651,811.00 |
| Subsidiary silver coins | 8,378,811 | 844,872.15 |
| Minor coins | 64,772,283 | 1,283,408.49 |

### WORLD'S COINAGE.

| CALENDAR YEARS. | Gold. | Silver, coining value. |
|---|---|---|
| 1887 | $124,992,465 | $163,411,397 |
| 1888 | 134,827,740 | 134,922,344 |
| 1889 | 167,731,286 | 132,280,659 |

The aggregate amount of coinage each year does not correctly represent the value of the annual product of gold and silver employed in coinage, for the reason that the coinages reported include recoinages of both domestic and foreign coin, as well as old material employed in coinage.

The data covering the recoinages of the calendar year 1889 are not sufficiently complete to afford any fair presentation of the amount of old coins melted down.

In addition to the coinage executed, bars of gold and silver were manufactured at the United States mints and assay offices to the value of $28,572,503.37, as follows:

| | |
|---|---|
| Gold | $22, 349, 752. 28 |
| Silver | 6, 222, 751. 09 |
| Total | 28, 572, 503. 37 |

## GOLD AND SILVER USED IN THE INDUSTRIAL ARTS IN THE UNITED STATES.

Inquiry has been prosecuted for the purpose of ascertaining the amount and value of the precious metals used in the industrial arts in this country during the calendar year 1889. These inquiries have been confined to ascertaining from government institutions and from private refineries the amount and value of the bars of gold and silver furnished to jewelers and manufacturers for industrial use.

The following table is a summary of the work of government and private institutions in the preparation of bars for industrial use during the calendar year 1889:

### VALUE OF GOLD AND SILVER BARS FURNISHED FOR USE IN MANUFACTURES AND THE ARTS DURING THE CALENDAR YEAR 1889.

| MATERIAL. | Total. | Gold. | Silver. |
|---|---|---|---|
| Total | $22, 193, 253 | $13, 623, 935 | $8, 569, 318 |
| United States coin | 429, 252 | 426, 879 | 2, 373 |
| Domestic bullion | 16, 984, 760 | 9, 686, 827 | 7, 297, 933 |
| Foreign coin and bullion | 949, 255 | 291, 258 | 657, 997 |
| Old material | 3, 829, 986 | 3, 218, 971 | 611, 015 |

The amount of domestic bullion used in the composition of jewelers' bars was: gold, $9,686,827; silver, $7,297,933, the latter corresponding to 6,090,496 fine ounces of silver, worth at the average price of silver for the calendar year about $5,701,000.

The amount of United States gold coin reported as having been melted for use in the manufacture of bars for industrial purposes during the calendar year 1889 was $426,879, against an estimated annual melting down of United States gold coin for industrial use, based on 4 censuses of actual consumption taken by the mint bureau, of $3,500,000.

Unless, therefore, there has been a decided falling off in the melting down of coin for industrial purposes by jewelers and others, the value of the precious metals used in the industrial arts in the United States during the calendar year 1889 approximated $16,697,000 gold and $8,766,000 silver (coining value).

In the report of the Tenth Census the estimated consumption of gold and silver in the industrial arts for the fiscal year ended June 30, 1880, was, gold, $10,000,000, and silver, $5,000,000.

## SILVER PURCHASES BY THE UNITED STATES GOVERNMENT.

The quantity of silver delivered during the calendar year 1889 on purchases for the coinage of the standard silver dollar under the requirements of the act of February 28, 1878, was 27,125,357.61 fine ounces, costing $25,379,510.60, an average cost of $0.935638 per fine ounce.

### MONTHLY PURCHASE AND COINAGE INTO SILVER DOLLARS DURING THE CALENDAR YEAR 1889.

| MONTHS. | Average price per fine ounce for previous month. | Number of fine ounces required to procure $2,000,000 worth of bullion. | Coining value in silver dollars. | Dollars coined. | Bullion contained. (Standard ounces.) | Cost of bullion coined. |
|---|---|---|---|---|---|---|
| Total | ............ | 25, 670, 066 | $33, 189, 578 | 34, 651, 811 | 29, 778, 900. 06 | $25, 028, 050. 29 |
| January | $0. 93581 | 2, 137, 186 | 2, 763, 230 | 3, 100, 000 | 2, 664, 062. 50 | 2, 247, 315. 04 |
| February | 0. 93616 | 2, 136, 387 | 2, 762, 197 | 2, 710, 300 | 2, 329, 164. 06 | 1, 962, 858. 15 |
| March | 0. 93752 | 2, 133, 288 | 2, 758, 190 | 3, 000, 025 | 2, 578, 146. 48 | 2, 171, 613. 57 |
| April | 0. 93652 | 2, 135, 566 | 2, 761, 136 | 2, 978, 000 | 2, 559, 218. 75 | 2, 149, 502. 65 |
| May | 0. 92918 | 2, 152, 435 | 2, 782, 946 | 3, 164, 025 | 2, 719, 083. 98 | 2, 278, 333. 80 |
| June | 0. 92893 | 2, 153, 015 | 2, 783, 696 | 3, 264, 110 | 2, 805, 094. 53 | 2, 346, 048. 43 |
| July | 0. 92547 | 2, 161, 064 | 2, 794, 103 | 1, 300, 000 | 1, 117, 187. 50 | 932, 485. 09 |
| August | 0. 92638 | 2, 158, 941 | 2, 791, 358 | 2, 875, 000 | 2, 470, 703. 13 | 2, 062, 129. 23 |
| September | 0. 92959 | 2, 151, 486 | 2, 781, 719 | 2, 860, 000 | 2, 457, 812. 50 | 2, 054, 448. 71 |
| October | 0. 93477 | 2, 139, 564 | 2, 766, 305 | 3, 100, 351 | 2, 664, 364. 13 | 2, 233, 123. 36 |
| November | 0. 94036 | 2, 126, 845 | 2, 749, 860 | 3, 300, 000 | 2, 835, 937. 50 | 2, 392, 960. 11 |
| December | 0. 95956 | 2, 084, 289 | 2, 694, 838 | 3, 000, 000 | 2, 578, 125. 00 | 2, 197, 232. 15 |

HIGHEST, LOWEST, AND AVERAGE PRICE IN LONDON OF SILVER BULLION 0.925 FINE, AND VALUE OF A FINE OUNCE EACH MONTH DURING THE CALENDAR YEAR 1889.

| MONTHS. | Highest. (Pence.) | Lowest. (Pence.) | Average price per ounce 0.925 fine British standard. (Pence.) | Equivalent value of a fine ounce with exchange at par, $4.8665. | Average monthly price at New York of exchange on London. | Equivalent value of a fine ounce, based on average monthly price and average rate of exchange. | Average monthly New York price of fine bar silver. |
|---|---|---|---|---|---|---|---|
| Average | ............ | ............ | 42.659— | $0.93533— | $4.8757+ | $0.93695— | $0.93631+ |
| January | 42.688 | 42.375 | 42.544 | 0.93261 | 4.8810 | 0.93616 | 0.93644 |
| February | 42.750 | 42.500 | 42.594 | 0.93371 | 4.8872 | 0.93752 | 0.93750 |
| March | 42.625 | 42.250 | 42.521 | 0.93211 | 4.8894 | 0.93652 | 0.93769 |
| April | 42.313 | 42.125 | 42.185 | 0.92474 | 4.8895 | 0.92918 | 0.92865 |
| May | 42.250 | 41.938 | 42.162 | 0.92424 | 4.8900 | 0.92893 | 0.92865 |
| June | 42.188 | 42.000 | 42.034 | 0.92143 | 4.8879 | 0.92547 | 0.92595 |
| July | 42.313 | 42.000 | 42.159 | 0.92417 | 4.8776 | 0.92638 | 0.92558 |
| August | 42.563 | 42.250 | 42.349 | 0.92834 | 4.8731 | 0.92959 | 0.92843 |
| September | 42.688 | 42.375 | 42.522 | 0.93213 | 4.8798 | 0.93477 | 0.92589 |
| October | 43.500 | 42.625 | 42.944 | 0.94382 | 4.8612 | 0.94036 | 0.94120 |
| November | 44.375 | 43.625 | 43.923 | 0.96284 | 4.8500 | 0.95956 | 0.96100 |
| December | 44.375 | 43.750 | 43.967 | 0.96381 | 4.8419 | 0.95894 | 0.95880 |

## STOCK OF MONEY IN THE UNITED STATES.

In view of the wide difference between the estimated and the visible stock of gold coin, the presumption is almost conclusive that either gold coin has left the country without being recorded or a very large amount is hoarded by the people of the United States in the shape of keepsakes and private savings.

The following table has been compiled from the latest data attainable for the purpose of exhibiting by way of comparison the stock of gold, silver, and paper money in circulation in the United States and in the 3 principal countries of Europe:

ESTIMATED AMOUNT OF GOLD, SILVER, AND NOTES IN CIRCULATION IN FRANCE, THE UNITED KINGDOM, GERMANY, AND THE UNITED STATES.

| COUNTRIES. | Population. | Total metallic and paper. | Gold circulation. | Silver circulation. | Notes outstanding. | PER CAPITA CIRCULATION. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Total. | Gold. | Silver. | Paper. |
| France | 38,219,000 | $2,194,000,000 | $900,000,000 | $700,000,000 | $594,000,000 | $57.41 | $23.55 | $18.32 | $15.54 |
| United Kingdom | 38,166,000 | 840,000,000 | 550,000,000 | 100,000,000 | 190,000,000 | 22.01 | 14.41 | 2.62 | 4.98 |
| Germany | 49,423,000 | 990,000,000 | 500,000,000 | 215,000,000 | 275,000,000 | 20.03 | 10.12 | 4.35 | 5.56 |
| United States | 62,653,000 | 1,430,634,459 | 375,607,112 | 116,298,802 | 938,728,545 | 22.83 | 5.99 | 1.86 | 14.98 |

In compiling this table the metallic reserves of the Bank of the United Kingdom, the Bank of France, and the Imperial Bank of Germany have been included in the amount of gold and silver in circulation, and the total bank notes outstanding in the amount of paper money in circulation, whereas in the United States the entire amount of gold and silver in the Treasury has been deducted.

In European statistics of circulation it is customary to deduct from the bank notes in circulation the metallic reserves held by the banks for their redemption against which the notes are issued, and to class as in circulation only the "uncovered" bank notes. This is done to prevent double employment, as both the notes issued and the specie held for their redemption do not perform the duty of a circulating medium at the same time. Following this method, which is that used by Dr. Soetbeer and other European statisticians, the following table has been compiled showing the amount of metallic money and "uncovered" notes in 3 of the principal countries of Europe and in the United States:

STOCK OF GOLD, SILVER, AND UNCOVERED NOTES IN FRANCE, THE UNITED KINGDOM, GERMANY, AND UNITED STATES.

| COUNTRIES. | Population. | Total metallic and uncovered stock. | Gold stock. | Silver stock. | Uncovered notes. | PER CAPITA. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Total. | Gold. | Silver. | Paper. |
| France | 38,219,000 | $1,704,000,000 | $900,000,000 | $700,000,000 | $104,000,000 | $44.59 | $23.55 | $18.32 | $2.72 |
| United Kingdom | 38,166,000 | 710,000,000 | 550,000,000 | 100,000,000 | 60,000,000 | 18.60 | 14.41 | 2.62 | 1.57 |
| Germany | 49,423,000 | 865,000,000 | 500,000,000 | 215,000,000 | 150,000,000 | 17.50 | 10.12 | 4.35 | 3.03 |
| United States | 62,653,000 | 1,560,457,214 | 689,275,007 | 438,388,624 | 432,793,583 | 24.91 | 11.00 | 7.00 | 6.91 |

In the preceding table the gold certificates outstanding are embraced in the gold stock and the silver certificates in the silver stock, and both amounts have been deducted from the amount of paper money outstanding.

From the legal-tender notes outstanding has been deducted $100,000,000 of gold coin held in the Treasury for their redemption, leaving as the amount of "uncovered" paper money in the United States $231,007,091 legal-tender notes, $192,730,050 national-bank notes, $9,000,000 certificates of deposit for legal-tender notes, and $56,442 "old demand" notes, a total of $432,793,583.

The following table exhibits the estimated stock of metallic and representative money in the United States and the location of the same January 1, 1890:

LOCATION OF THE MONEYS OF THE UNITED STATES, JANUARY 1, 1890.

| MONEYS. | Total. | In Treasury. | In national banks (December 11, 1889). | In other banks and general circulation. |
|---|---|---|---|---|
| METALLIC. | | | | |
| Total | $1, 127, 663, 631 | $635, 757, 717 | $82, 459, 193 | $409, 446, 721 |
| Gold bullion | 67, 265, 944 | 67, 265, 944 | .............. | .............. |
| Silver bullion | 11, 626, 395 | 11, 626, 395 | .............. | .............. |
| Gold coin | 622, 009, 063 | 246, 401, 951 | 71, 910, 467 | 303, 696, 645 |
| Silver dollars | 349, 938, 001 | 288, 535, 500 | 6, 459, 483 | 54, 943, 018 |
| Subsidiary silver coin | 76, 824, 228 | 21, 927, 927 | 4, 089, 243 | 50, 807, 058 |
| PAPER. | | | | |
| Total | 993, 041, 891 | 54, 313, 346 | 205, 101, 229 | 733, 627, 316 |
| Legal-tender notes | 346, 681, 016 | a15, 673, 925 | 84, 490, 894 | 246, 516, 197 |
| Old demand notes | 56, 442 | .............. | .............. | 56, 442 |
| Certificates of deposit | 9, 570, 000 | 570, 000 | 9, 000, 000 | .............. |
| Gold certificates | 154, 301, 989 | 31, 316, 100 | 77, 408, 260 | 45, 577, 629 |
| Silver certificates | 285, 202, 039 | 2, 252, 966 | 11, 422, 004 | 271, 527, 069 |
| National-bank notes | 197, 230, 405 | b4, 500, 355 | c22, 780, 071 | 169, 949, 979 |

a Includes $9,000,000 held for redemption of certificates of deposit for legal-tender notes, act of June 8, 1872.
b Includes $4,367,102 in process of redemption.
c Includes $2,391,264 of their own notes held by the different national banks.

The ownership, as distinguished from the location, of the estimated stock of United States gold and silver coin and bullion is exhibited in the following table:

OWNERSHIP OF GOLD AND SILVER IN THE UNITED STATES, JANUARY 1, 1890.

| OWNERSHIP. | Total gold and silver coin and bullion. | Gold coin and bullion. | SILVER COIN AND BULLION. | | | |
|---|---|---|---|---|---|---|
| | | | Total silver. | Silver dollars. | Subsidiary silver coin. | Silver bullion. |
| Total | $1, 127, 663, 631 | $689, 275, 007 | $438, 388, 624 | $349, 938, 001 | $76, 824, 228 | $11, 626, 395 |
| United States treasury | 229, 822, 755 | a190, 682, 006 | 39, 140, 749 | b5, 586, 427 | 21, 927, 927 | 11, 626, 395 |
| National banks (December 11, 1889) | 171, 089, 457 | c149, 318, 727 | 21, 770, 730 | d17, 681, 487 | 4, 089, 243 | .............. |
| Banks other than national (gold-coin holdings reported to director of the mint). | 726, 751, 419 | 31, 212, 417 | 377, 477, 145 | 326, 670, 087 | 50, 807, 058 | .............. |
| Banks other than national (not reporting) and in private hands | | 318, 061, 857 | | | | |

a Gold coin in the Treasury and gold bullion in the mints and assay offices, exclusive of $122,985,889 gold certificates outstanding.
b Silver dollars in the Treasury, exclusive of $282,949,073 silver certificates outstanding.
c Includes Treasury and clearing-house gold certificates, $77,408,260.
d Includes Treasury silver certificates, $11,222,004.

COMPARISON OF THE OFFICIAL TABLES OF THE STOCK OF GOLD COIN WITH THE VISIBLE STOCK, JANUARY 1, 1890.

| | | |
|---|---|---|
| United States gold coin | | $622, 009, 063 |
| Gold bullion in mints and assay offices | | 67, 265, 944 |
| | | 689, 275, 007 |
| Visible stock: | | |
| Gold coin in United States treasury and branches | $246, 401, 951 | |
| Gold bullion | 67, 265, 944 | |
| In national banks | 71, 910, 467 | |
| In other banks | 34, 000, 000 | |
| Total visible stock | | 419, 578, 362 |
| Difference | | 269, 696, 645 |

In this statement are included hoardings and other uses withdrawing the coin from circulation.

## COINAGES OF NATIONS.

The amount of gold and silver coined by each country varies greatly from year to year, but as showing the amount coined in each of the past 10 years the following table has been compiled from successive reports of the director of the United States mint. This coinage includes also recoinage from old coins.

### COINAGES OF VARIOUS NATIONS.

| COUNTRIES. | 1880. | | 1881. | | 1882. | | 1883. | |
|---|---|---|---|---|---|---|---|---|
| | Gold. | Silver. | Gold. | Silver. | Gold. | Silver. | Gold. | Silver. |
| Total | $149, 645, 236 | $82, 397, 154 | $147, 015, 275 | $108, 010, 086 | $99, 697, 170 | $110, 785, 934 | $104, 845, 114 | $109, 306, 705 |
| United States | 62, 308, 279 | 27, 409, 706 | 96, 850, 890 | 27, 939, 203 | 65, 887, 685 | 27, 972, 035 | 29, 241, 990 | 29, 245, 989 |
| Mexico | | | 438, 778 | 24, 139, 023 | 452, 590 | 25, 146, 260 | 407, 600 | 24, 083, 921 |
| Great Britain | 20, 196, 228 | 3, 705, 878 | | 4, 852, 523 | | 1, 021, 381 | 6, 831, 169 | 6, 201, 517 |
| Australia | 22, 151, 334 | | 19, 699, 115 | | 18, 701, 959 | | 19, 903, 722 | |
| India (*a*) | 69, 670 | 40, 002, 173 | | 20, 682, 625 | 170, 543 | 29, 386, 322 | 67, 044 | 24, 927, 400 |
| Canada | | | | | | | | |
| France | | | 418, 231 | 1, 299, 554 | 722, 206 | 223, 853 | | |
| Roumania | | | | 4, 747, 800 | | | | |
| Cochin China | | | | | | | | |
| Monaco | | | | | | | | |
| Belgium | | 150, 639 | | 38, 055 | 2, 016, 117 | | | |
| Italy | 499, 997 | | 3, 253, 988 | 1, 598, 346 | | | 785, 027 | |
| Switzerland | | | | | | | 965, 000 | |
| Spain | 33, 113, 719 | 268, 955 | 21, 067, 127 | 3, 080, 193 | 1, 996, 310 | 10, 671, 842 | 3, 327, 235 | 10, 523, 421 |
| Portugal | 348, 765 | 145, 492 | 245, 160 | | 162, 000 | | 217, 080 | |
| Netherlands | 259, 313 | 40, 200 | | | | 608, 312 | | 81, 095 |
| Germany | 6, 662, 153 | | 1, 634, 189 | | 3, 167, 085 | 6, 407, 157 | 21, 002, 897 | 594, 564 |
| Austria-Hungary (*b*) | 2, 468, 029 | 8, 373, 563 | 2, 429, 998 | 9, 028, 671 | 2, 829, 590 | 3, 122, 819 | 2, 154, 390 | 5, 552, 191 |
| Norway | | 499 | | 28, 930 | | 69, 680 | 192, 708 | 37, 520 |
| Sweden | 752, 992 | 223, 094 | 340, 275 | 290, 137 | 39, 876 | 17, 707 | 436, 619 | 250, 468 |
| Denmark | | | | | | | | |
| Russia (*c*) | | | | | | | 12, 793, 575 | |
| Turkey | | | | | 2, 960, 056 | | 1, 344, 640 | 44, 000 |
| Siam | | | | | | | | |
| Egypt | | | | | | | | |
| Japan | 460, 365 | 2, 076, 955 | 490, 585 | 4, 514, 043 | 565, 645 | 4, 367, 393 | 544, 290 | 3, 120, 892 |
| Hayti | | | | 780, 000 | | | | |
| Chile | | | 125, 280 | 3, 020, 000 | | | | |
| Argentine Republic | | | | | | | 4, 530, 210 | 1, 715, 445 |
| Peru | | | | | | | | |
| Persia | | | | | | | 47, 117 | 605, 579 |
| Colombia | | | | | | | | 699, 114 |
| Venezuela | 324, 024 | | | | | | | |
| Guatemala | | | | | | | | |
| Brazil | 30, 368 | | 21, 659 | | 25, 508 | 9, 994 | 52, 801 | 23, 589 |
| Honduras | | | | | | 76, 314 | | |
| Congo | | | | | | | | |
| Nicaragua | | | | | | | | |
| Straits Settlements | | | | | | | | |
| Hawaiian Islands | | | | | | | | |
| Ecuador | | | | | | | | |
| Hongkong | | | | | | | | |
| Costa Rica | | | | | | | | |
| Bolivia | | | | 1, 970, 983 | | 1, 684, 865 | | 1, 600, 000 |

*a* Rupee calculated at coining rate, $0.4737.

*b* Silver florin calculated at coining rate, $0.4820.

*c* Silver ruble calculated at coining rate, $0.7718.

## COINAGES OF VARIOUS NATIONS—Continued.

| COUNTRIES. | 1884. |  | 1885. |  | 1886. |  |
|---|---|---|---|---|---|---|
|  | Gold. | Silver. | Gold. | Silver. | Gold. | Silver. |
| Total | $99, 432, 795 | $95, 832, 084 | $95, 757, 582 | $126, 764, 574 | $94, 642, 070 | $124, 854, 101 |
| United States | 23, 991, 756 | 28, 534, 866 | 27, 773, 012 | 28, 962, 176 | 28, 945, 542 | 32, 086, 709 |
| Mexico | 328, 698 | 25, 377, 378 | 423, 250 | 25, 840, 727 | 367, 490 | 26, 991, 804 |
| Great Britain | 11, 309, 819 | 3, 204, 824 | 14, 366, 677 | 3, 540, 719 |  | 2, 031, 194 |
| Australia | 22, 196, 106 |  | 21, 694, 857 |  | 22, 524, 595 |  |
| India (*a*) |  | 17, 353, 531 | 106, 987 | 48, 487, 114 |  | 27, 121, 414 |
| Canada |  |  |  |  |  | 225, 000 |
| France |  | 23, 160 | 55, 854 |  | 4, 455, 733 | 29, 795 |
| Roumania |  |  |  |  |  |  |
| Cochin China |  | 120, 000 |  | 1, 279, 511 |  | 3, 215, 771 |
| Monaco |  |  | 164, 648 |  | 289, 500 |  |
| Belgium |  |  |  |  |  | 921, 768 |
| Italy | 62, 165 | 2, 121, 953 | 635, 873 | 230, 831 | 227, 771 | 1, 795, 364 |
| Switzerland |  |  |  |  | 965, 000 | 501, 800 |
| Spain | 4, 983, 004 | 6, 738, 971 | 2, 435, 108 | 3, 678, 314 | 2, 369, 765 | 5, 057, 506 |
| Portugal | 186, 840 |  | 246, 240 |  | 179, 626 | 299, 765 |
| Netherlands |  | 182, 910 | 280, 000 | 80, 400 | 217, 647 |  |
| Germany | 13, 723, 494 | 114, 319 | 1, 939, 443 | 577, 664 | 8, 506, 210 | 1, 153, 963 |
| Austria-Hungary (*b*) | 2, 444, 004 | 4, 987, 781 | 2, 791, 958 | 4, 147, 659 | 2, 684, 139 | 4, 384, 433 |
| Norway |  |  |  | 53, 600 | 539, 484 |  |
| Sweden | 1, 022, 420 | 132, 784 | 33, 500 | 78, 281 | 982, 188 |  |
| Denmark |  |  |  |  |  | 13, 624 |
| Russia (*c*) | 18, 615, 074 | 1, 238, 746 | 20, 685, 852 | 964, 769 | 14, 761, 717 | 1, 304, 101 |
| Turkey |  |  |  |  | 3, 652, 000 | 880, 000 |
| Siam |  |  |  |  |  |  |
| Egypt |  |  |  |  |  | 3, 204, 151 |
| Japan | 569, 415 | 3, 599, 912 | 1, 004, 005 | 6, 320, 927 | 900, 165 | 9, 086, 077 |
| Hayti |  |  |  |  |  | 144, 750 |
| Chile |  |  | 77, 580 | 564, 080 | 37, 210 | 966, 080 |
| Argentine Republic |  |  | 984, 000 |  | 1, 988, 670 |  |
| Peru |  | 1, 400, 949 |  | 1, 326, 266 |  | 592, 065 |
| Persia |  |  |  |  |  |  |
| Colombia |  |  |  |  | 26, 965 | 1, 354, 826 |
| Venezuela |  |  |  |  |  | 1, 286, 345 |
| Guatemala |  |  |  |  |  | 27, 387 |
| Brazil |  |  | 58, 738 | 12, 090 | 20, 653 | 30, 373 |
| Honduras |  |  |  | 106, 510 |  |  |
| Congo |  |  |  |  |  |  |
| Nicaragua |  |  |  | 400, 000 |  |  |
| Straits Settlements |  |  |  |  |  |  |
| Hawaiian Islands |  | 700, 000 |  |  |  |  |
| Ecuador |  |  |  |  |  |  |
| Hongkong |  |  |  |  |  |  |
| Costa Rica |  |  |  | 112, 936 |  | 148, 036 |
| Bolivia |  |  |  |  |  |  |

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*a* Rupee calculated at coining rate, $0.4737. *b* Silver florin calculated at coining rate, $0.4820. *c* Silver ruble calculated at coining-rate, $0.7718.

COINAGES OF VARIOUS NATIONS—Continued.

| COUNTRIES. | 1887. |  | 1888. |  | 1889. |  |
|---|---|---|---|---|---|---|
|  | Gold. | Silver. | Gold. | Silver. | Gold. | Silver. |
| Total | $124,992,465 | $163,411,397 | $134,828,855 | $134,922,344 | $168,901,519 | $138,444,595 |
| United States | 23,972,383 | 35,191,081 | 31,380,808 | 33,025,606 | 21,413,931 | 35,496,683 |
| Mexico | 398,647 | 26,844,031 | 300,480 | 26,658,964 | 319,907 | 25,294,726 |
| Great Britain | 9,728,498 | 4,142,136 | 9,893,375 | 3,681,886 | 36,502,536 | 10,827,602 |
| Australia | 24,122,267 |  | 24,415,230 |  | 29,325,529 |  |
| India (*a*) | 4,249 | 44,142,013 | 108,216 | 36,297,132 | 110,328 | 37,937,814 |
| Canada |  | 85,000 |  | 247,174 |  | 16,585 |
| France | 4,760,960 | 1,719,742 | 106,949 | 1,112,379 | 3,273,215 | 71 |
| Roumania |  |  |  |  |  |  |
| Cochin China |  | 3,126,410 |  | 1,100,518 |  | 1,302,581 |
| Monaco |  |  |  |  |  |  |
| Belgium |  | 583,632 |  |  |  |  |
| Italy |  | 6,253,200 | 469,750 |  |  | 60,208 |
| Switzerland |  | 270,200 | 16,984 |  | 386,000 | 217,125 |
| Spain |  | 11,389,414 |  | 4,436,804 | 3,378,631 | 4,716,029 |
| Portugal | 270,000 | 960,120 | 102,600 | 1,533,600 | 96,120 | 680,400 |
| Netherlands | 163,831 | 76,380 | 143,051 |  | 823,943 | 132,660 |
| Germany | 28,135,270 | 715,343 | 34,340,722 | 989,127 | 48,166,245 | 177,079 |
| Austria-Hungary (*b*) | 2,669,750 | 5,556,395 | 2,747,633 | 5,516,190 | 3,294,987 | 4,528,259 |
| Norway |  | 80,400 |  | 53,600 |  | 53,600 |
| Sweden | 314,830 | 56,082 |  | 16,714 | 1,080,040 | 142,253 |
| Denmark |  |  |  | 62,483 |  | 27,607 |
| Russia (*c*) | 20,109,276 | 1,551,710 | 20,460,491 | 1,163,126 | 18,855,097 | 1,153,651 |
| Turkey |  |  | 66,000 | 74,448 |  |  |
| Siam |  | 2,216,065 |  |  |  | 1,446,626 |
| Egypt | 246,354 | 2,159,690 | 257,154 | 8,483 |  |  |
| Japan | 897,420 | 10,279,555 | 974,335 | 10,222,108 | 1,775,010 | 9,516,359 |
| Hayti |  | 500,000 |  |  |  |  |
| Chile | 25,360 | 333,000 | 42,170 | 122,375 |  |  |
| Argentine Republic | 9,178,370 |  | 8,316,325 |  |  |  |
| Peru |  | 1,685,000 |  | 3,258,000 |  | 2,842,531 |
| Colombia |  | 663,069 |  | 600,443 |  | 216,136 |
| Venezuela |  |  | 660,500 | 272,000 |  |  |
| Brazil |  |  | 26,082 | 883,555 |  |  |
| Honduras |  | 71,978 |  |  |  |  |
| Congo |  | 19,300 |  |  |  |  |
| Nicaragua |  | 400,000 |  |  |  |  |
| Straits Settlements |  | 177,000 |  | 244,000 |  | 300,000 |
| Hawaiian Islands |  |  |  |  |  |  |
| Ecuador |  |  |  | 473,177 |  |  |
| Hongkong |  | 400,000 |  | 1,105,000 |  | 1,100,000 |
| Costa Rica |  |  |  |  |  | 258,010 |
| Bolivia |  | 1,763,451 |  | 1,763,452 |  |  |

*a* Rupee calculated at coining rate, $0.4737.

*b* Silver florin calculated at coining rate, $0.4820.

*c* Silver rouble calculated at coining rate, $0.7718.

### AGGREGATE COINAGE OF THE PRINCIPAL COUNTRIES.

The following table (from the British report of 1887) gives the aggregate gold and silver coinage of the United States, England, Germany, Russia, France, Belgium, Italy, Austria, and India (which latter, however, coined only silver in each year from 1852 to 1885) stated in millions of pounds sterling:

| YEARS. | Gold. | Silver. | YEARS. | Gold. | Silver. |
|---|---|---|---|---|---|
| 1852 | 21.8 | 9.1 | 1869 | 26.7 | 12.5 |
| 1853 | 32.8 | 9.7 | 1870 | 16.6 | 17.1 |
| 1854 | 30.8 | 7.9 | 1871 | 21.9 | 9.0 |
| 1855 | 33.8 | 3.8 | 1872 | 45.1 | 7.9 |
| 1856 | 35.3 | 11.0 | 1873 | 45.0 | 20.1 |
| 1857 | 32.4 | 13.4 | 1874 | 27.3 | 13.4 |
| 1858 | 37.7 | 21.1 | 1875 | 35.2 | 20.6 |
| 1859 | 39.2 | 17.9 | 1876 | 37.6 | 23.2 |
| 1860 | 28.6 | 19.7 | 1877 | 38.9 | 18.9 |
| 1861 | 27.0 | 12.9 | 1878 | 37.8 | 28.1 |
| 1862 | 32.5 | 12.2 | 1879 | 21.0 | 20.8 |
| 1863 | 28.3 | 12.6 | 1880 | 26.6 | 19.5 |
| 1864 | 33.4 | 15.6 | 1881 | 26.2 | 14.1 |
| 1865 | 22.8 | 15.4 | 1882 | 33.7 | 10.0 |
| 1866 | 32.6 | 21.2 | 1883 | 21.2 | 16.3 |
| 1867 | 21.0 | 17.5 | 1884 | 19.2 | 12.2 |
| 1868 | 25.3 | 13.5 | 1885 | 17.4 | 14.3 |

## CONDITION OF THE METALLURGY OF GOLD AND SILVER IN 1889, FROM EXAMPLES IN SUCCESSFUL OPERATION.

A scientific investigation of the technical condition of the gold and silver industry has not been attempted, yet it has seemed so important that this report should place on record the present condition of the metallurgy of gold and silver that herewith are given some of the best monographs on the latest successful practice in gold milling. These are: a general paper giving the present condition of the metallurgy of gold, by Mr. C. H. Aaron; a paper describing the most advanced and successful application of barrel chlorination of gold ores, by Mr. John E. Rothwell; a paper giving two examples of the cheapest recorded mining and milling of gold ore in 1889 and 1890; and, finally, a description of Mr. Gutzkow's method for refining silver bullion, which is now in successful operation at several large works in the United States. These papers, prepared by men who are successfully carrying out the processes they describe, represent in concise form the most improved practice in gold metallurgy and show the state of the art at the present time.

### GOLD MINING.

The following notes on gold milling were contributed by Mr. C. H. Aaron, metallurgist, to the Engineering and Mining Journal, New York, August 10, 1889:

> These notes are based partly on the writer's own observation and experience, partly on information received privately, and partly on a late report of the state mineralogist of California.
>
> In many gold quartz mills no attempt is made to ascertain the true gold content per ton of the rock crushed; consequently the proportions of recovery and loss are not known. This seems to be due in part to the conceit of some mill men, who imagine that what they fail to save can not be saved, and in part to an idea that it is not possible to obtain samples of gold rock which will correctly represent the average. The question of individual skill and ability is beyond discussion, and the writer admits that the average loss of free gold and, where concentrators are used, of gold in sulphurets also, is below the estimate of many writers and workers, some of whom put it as high as 30 per cent; but it is admitted by all that there is a loss, and the reduction of that to the lowest possible limit, consistent with the object in view, which is profit, should be the subject of constant endeavor, and the most likely thing to promote such endeavor is an exact knowledge of the extent of the loss in percentage of the original content of the rock. The absolute loss per ton is easily ascertained by the assays of tailings, of which correct samples can readily be taken, but, in order to reduce this to percentage, it is necessary to know the weight and value per ton of the rock crushed. This is not so difficult as many suppose. In some cases, that is, where the gold is distributed in extremely small particles through the gangue, samples of gold rock can be taken, before it goes into the battery, with the same facility as in the case of smelting ores. Samples should be taken in measured quantity every hour from the feeders, or from the breakers, and the accumulation of each 24 hours well mixed, crushed by a small breaker, reduced by quartering to the proper extent, and the resulting quantity passed through a fine sieve for assay. Any coarse gold that may refuse the sieve must be separately estimated and the assay of the powder corrected in the usual way, as explained in works on assaying. Samples thus taken at the Bunker Hill mine during 5 years have not varied more than 10 cents per ton from the milling results. The free gold recovered and the gold contained in the concentrates and tailings correspond invariably to the monthly battery samples. In case the rock contains a considerable proportion of coarse gold, the battery samples will be unreliable, and the required information must be obtained in a different way. The weight of the tailings equals that of the ore crushed, except where concentration is practiced, in which case it is only necessary to deduct from the known weight of rock crushed that of the concentrates in order to obtain the weight of the final

tailings. If now the tailings are properly sampled and assayed, and their total value for a given period is added to that of the amalgam and of the concentrates for the same period, we shall have all the data necessary for calculating the percentage of loss in the crushing. The subsequent loss in treating the concentrates is another matter. It will, of course, be necessary to weigh the ore which is sent to the mill, and to correct the weight for moisture in case the rock is not dry. This is a very easy matter if proper arrangements are made.

By free gold is meant gold which, originally inclosed in the gangue, has been or might have been released by mechanical means, and, while including such gold as, though imbedded in galena and other sulphurets, can be released by crushing the inclosing substance, excludes that portion of the metal which exists in the sulphurets in such a condition as to be practically incapable of amalgamation in the batteries or on the plates. The first thing to be ascertained is how much of the gold is being carried off in the tailings. There should be a systematic weighing of the rock crushed in each run and sampling of the tailings, both of which can and should be done automatically. The concentrates must be also weighed and a correct sample taken and sealed in a bottle, in order that the percentage of water and the gold value per ton may be ascertained. The sample, with a statement of the value of free gold saved, the weight of ore crushed, and the weight of the concentrates, should be sent to a competent assayer, and he will report the value per ton of the ore worked and the percentage lost. Next an investigation should be made as to the manner and causes of the loss, as a guide to the direction in which to seek such remedy. Among these causes are or may be the following:

### FLOTATION.

The loss from this will increase, first, with the fineness of the golden particles; second, in absolute quantity, though not in percentage of the whole, with the richness of the rock in such fine particles; third, in percentage, though not in absolute quantity, with the poverty of the rock in such gold; fourth, with the quantity of water used; fifth, with the muddiness of the water; hence a just medium must be found in this respect by trial, so much water being applied as to dilute the mud as far as possible without causing much of the gold to be swept away by the too forcible current. In this connection the inclination of the plates must be considered, and it seems probable that Gauthier's shaking apron will be found very useful by allowing less inclination with a given quantity of water, or less water with a given inclination. Sixth, on the degree to which the coarser particles of gold and the amalgam are abraded and comminuted by the stamps, which indicates that the prevalent practice of amalgamating as much as possible in the mortars, by means of fine screens, high discharge, and a minimum of water in the battery, with a proportionately greater addition on the plates, may not always be the best, and that the grinding action claimed for revolving stamps may not be an advantage.

### INCLOSURE IN PARTICLES OF GANGUE.

Evidently there is no remedy for this but finer crushing; but a consideration of the causes of loss in the preceding paragraph will show that there is a limit in practice to the fineness to which the ore can be crushed in one operation with advantage, for the finer it is crushed the more will the particles of gold be comminuted, as well as the rock, and the more will the settling of the gold to a contact with the amalgamated plates be obstructed by the fine particles of rock with which the water will be charged to excess. This suggests that it might, in some cases, be found advantageous to submit the rock to two distinct operations of crushing and amalgamation, with an intermediate separation of slimes. This is done, in effect, at the Plumas-Eureka mine, where the tailings from the mill are taken up by Italians, who pay a royalty for the privilege, and passed into wide, shallow boxes, which retain the sand while the slimes pass on. The sands are then ground and amalgamated in arrastres driven by water power. There are about 30 arrastres thus occupied on the tailings from that mill.

### INAPTNESS OF THE GOLD TO AMALGAMATE.

The difficulty occasionally met with in causing the gold to unite with the quicksilver is sometimes due to a film of iron oxide or other substance which envelopes the auriferous grains. This is notably the case with the gold in beach sand, which sometimes obstinately refuses amalgamation until cleaned by chemical or mechanical means. When gold in quartz is in this condition it may be benefited by a certain amount of grinding, but it seems probable that the difficulty is sometimes caused by the quality of the water used. Mr. William Skey has made a study of this subject, and he has said that the presence of iron sulphate in the water is injurious to amalgamation, and iron sulphate is often to be found in the water coming from a mine, which is sometimes used in the battery. It has been proved that gold which has been hammered does not amalgamate well, and especially when hammered in the presence of quartz or other matter, particles of which then adhere to the metal and prevent the contact of quicksilver, which is another argument in favor of two or more separate crushing and amalgamating operations. The temperature of the water used has a considerable influence, and in some mills the water for the batteries is warmed artificially in cold weather. Also some drift gravel mines suspend operations during the winter for the same reason. In one instance, at least, it has been found advantageous to allow a small steam of solution of potassium cyanide to flow constantly into the battery, and I think it would be still better if some red oxide of mercury were dissolved in the cyanide solution. In such a liquid every particle of gold becomes coated with quicksilver. I have found gold in beach sand which refused to amalgamate even with the aid of potassium cyanide, but yielded instantly in presence of mercury cyanide in potassium cyanide solution. As these salts are rather expensive, it would be well to save the water and use it again in the battery if it could be cleared sufficiently from slimes. A little lime would be useful also if there should be any soluble iron or copper salt in the water.

### IMPURE MERCURY.

It is generally understood that the presence of lead, copper, mercurous oxide, sulphur, etc., in the mercury is injurious to the amalgamation of gold. Sometimes the ore contains sulphate of lead, which, being to some extent reduced to the metallic state by the chemical action of the iron battery, will amalgamate with the quicksilver. In a similar manner, soluble salts of copper, either in the ore or in the water, cause a precipitation and amalgamation of copper, which, though less injurious than lead, and in one way beneficial by causing the iron surfaces to become coated with quicksilver, thus giving additional opportunity for catching the fine gold, is still injurious. In all such cases the quicksilver strained from the amalgamation should be purified before being used again. It seems probable that the injurious effect of base metal in the quicksilver may be due rather to the formation of oxides than to the metal itself; at all events, the effect is bad, and those who have investigated the subject have come to the conclusion that pure mercury, or silver amalgam, is best, though there is some reason to think that zinc amalgam is sometimes useful, and cadmium amalgam shows remarkable readiness to attach gold to itself.

An instance is recorded of gold failing to amalgamate immediately in pans. The material treated was a coarse sand saved from the tailings in "riffle sluices", and containing gold to the value of $23 per ton, also a little iron oxide and a few sulphurets. After grinding in the pans 4 hours, the mullers were raised, quicksilver was added, and the working was continued 2 hours. No gold was found in the quicksilver, and the tailings assayed the same as at first. After trying repeatedly with the same result, the sand was ground to an impalpable pulp, allowed to dry during a couple of days, and then worked in the pan with raised muller. By this method from 85 to 90 per cent of the value was recovered. It is to be presumed the gold was in the fine particles of pyrite, which become oxidized by exposure when finely ground.

In order to remove small quantities of copper and lead from mercury retorting is not necessary. Such impurities may be removed by simply keeping the quicksilver for some hours in a wooden or any suitable vessel (for instance, an enameled pot) under dilute nitric acid, which is better warmed, and occasionally the metal should be stirred. The acid will dissolve the copper and lead until it becomes saturated. It may also dissolve some mercury, but that will be deposited again when a fresh lot containing copper or lead is treated with it, or the dissolved quicksilver may be recovered by immersing a piece of copper in the liquid. It is likely that the amalgam removed from the plates will contain a little copper, and it might be as well to keep the stock of quicksilver always under dilute nitric acid. When wanted for use it should be washed with clean water. The precipitation of lead or copper in the mortars may be prevented by adding a little soda or milk of lime to the water used, or by causing that to flow over broken limestone if the difficulty is in the water itself and not in the ore. Oxygen, sulphur, and chlorine may be removed from quicksilver by the addition of sodium amalgam, but an excess should be avoided. Lead is not usually wholly removed by retorting unless the quicksilver is covered to the depth of an inch or two with powdered charcoal. Leady quicksilver retorted once without charcoal will show a residue of lead when distilled a second time with charcoal.

### BAD CONDITION OF PLATES.

Discoloration of the amalgamated copper plates, indicating oxidation of the copper, is one of the difficulties of the gold mill man. This is an interesting and important subject for investigation in regard to which many inquiries have been made. The electroplating of the copper surfaces does not seem to be efficient in preventing discoloration in all cases, and is not universally favored by mill men. Some consider the silver plating as very advantageous, while others say it is void of merit. One man observed that, although the silver soon wears off, yet when this occurs it leaves the plate in good condition for saving gold. A remarkable fact is that in the lower mill of the Sierra Buttes Company they discarded silvered plates, for the reason that the silver disappeared so soon that it would cost too much for the frequent replating necessary, while in the upper mill of the same company it is, to use the language of the superintendent, "impossible to work without silvered plates". The only observed difference between the two cases is that in the lower mill the rock worked contains a small portion of sulphurets, chiefly iron pyrites, while the upper mill works surface ore with no sulphurets. But in the Plumas-Eureka mill the ore contains pyrites as well as galena, and in the mills of the Washington district, in Nevada county, they have pyrrhotite and zinc blende, yet all these mills use silvered plates. In the latter mills it is found that with plain copper plates the quicksilver soon wears off. In this connection the following results have been obtained by experiment: pieces of sheet copper were coated with quicksilver and exposed to immersion in Spring Valley water. The plates which were amalgamated with the aid of nitric acid and mercuric chloride became tarnished in a few minutes and, on being cleaned with solution of potassium cyanide, washed in water, and again exposed, were again promptly tarnished, and so on indefinitely. Plates amalgamated by means of potassium cyanide, not using nitric acid, resisted tarnishing during the first hour, after which they behaved in the same manner as those on which nitric acid was used. Tarnishing was lessened by the addition to the water of slaked lime, and was prevented by a small quantity of ferrous sulphate, also by a trace of potassium bisulphate, not at all by caustic potash. Tarnishing was permanently prevented by placing an iron nail in contact with the amalgamated strip of sheet copper; also by contact with a piece of zinc. This makes a galvanic couple, and the oxidation is transferred to the more positive iron or zinc. Iron pyrites on the plate and in the water had no perceptible effect. One of the strips was then smeared with zinc amalgam and it remained bright for a number of hours, but after 24 hours was slightly tarnished. Another strip treated with a little mercury containing a little cadmium retained its color 3 days. In view of these and other known facts, it is recommended that mill men who have trouble with their plates should make some experiments, each separately, as follows: (1) place some bars of iron on the apron, say one across the upper end and one on each side edge, also one in the middle; (2) use zinc amalgam on the apron; (3) dissolve a little cadmium in the quicksilver for use on the apron and in the mortar; (4) fix a tank so as to deliver a small stream of water, containing potassium cyanide, into the mortar constantly while crushing. This has been done in some mills with good effect.

Those who have occasion to work auriferous material in pans would do well to try a solution of potassium cyanide in which a little red oxide of mercury is dissolved. The effect of this solution is to coat every particle of gold with quicksilver, which greatly aids the amalgamation. Not too much of the solution must be used, as it dissolves gold; however, it is believed that the dissolved gold can be recovered by using zinc amalgam in the pan toward the end of the operation. Before adding the solution the pulp should be made slightly alkaline by the addition of a little potash or soda. It is believed by many that zinc amalgam is very effective in catching gold, and still greater efficiency is claimed for cadmium amalgam. The pressure of zinc blende in the ore has probably a favorable effect on amalgamation by tending to prevent oxidation of the plates, with which it forms a galvanic couple in the same way as does a piece of zinc.

As to the loss of auriferous sulphurets, admitting that the best known concentrators are used with the requisite skill and care as to the adjustment of the machine, and the quantity of ore and water supplied to it, the manifest causes of the loss are similar to those of free gold, mentioned in the first two paragraphs. Flotation is promoted by the fineness of the particles of sulphurets and by the quantity and rapidity of the flow and turbidity of the water, to which may be added two other causes, namely, the tendency of cubical grains, as of some galena and pyrites, to roll down the inclined apron of the machines, and the property which some sulphurets have of not being wetted by water, in consequence of which, though specifically heavier than water, and remaining submerged when once beneath the surface, they will float if removed from beneath the water and again assailed by a wavelet. This phenomenon was observed particularly in Arizona, where an ore containing copper pyrites was treated on an Embrey concentrator, which is a traveling belt with an "end shake". The sulphurets would remain on the belt until the travel had carried them to a point beyond the jets, where the reflux of the water would leave them stranded, as it were, and when again overtaken by the wavelet produced by the "end shake", or longitudinal oscillation of the belt, would float. On viewing the belt from a suitable position, the surface of the water upon it was seen constantly covered by the floating particles. The attempt to concentrate the ore was a failure, the waste being too great. Perhaps a machine of a different class would have been more successful.

The loss of particles by rolling will probably be prevented by the new corrugated belts which are now being introduced with the Frue machines. Some loss of sulphurets may be occasioned by their not being entirely separated from the rock particles, in consequence of which there is not sufficient difference of density between the compound mass and the particles of pure gangue to enable a separation to be effected. The percentage of sulphurets which is lost is even more rarely known than that of the gold, and is more difficult to determine. The percentage of value saved from that going on to the concentrators is readily found by assays of the pulp supplied to the machines and of the tailings leaving them, corrected for the proportion of the weight which is retained as headings. Thus, suppose the material to be concentrated assays $2 per ton and the tailings assay 20 cents per ton, while 1 ton in 10 is retained as headings, we have in 10 tons of material $20, in 9 tons of tailings $1.80; consequently the 1 ton of headings must contain $18.20, and the recovery of value by concentration is 91 per cent.

The loss of quicksilver on the mother lode varies from 1 to 2 cents' worth per ton of ore usually, according to the richness of the ore. The monthly loss at the Keystone mill one year was 1,276 ounces troy, and 10 ounces additional in retorting; another, 861 ounces troy, and 10 ounces additional in retorting. At the Bunker Hill mine, 67.5 pounds avoirdupois are lost monthly, with about the same number of tons of rock crushed, say 100 tons per day, or 3,000 tons per month. Testing tailings in a horn does not show at these mills any quicksilver or flowered amalgam usually, but only apparently a trifling amount of sulphurets. The loss of mercury is caused largely by floating, and is usually less where the outside plates are cleaned up every day or two. In the few cases in which the loss is stated in gold mills it amounts to only a small fraction of an ounce to the ton of ore, and does not of itself constitute a serious item of expense; but the question suggests itself whether or not the lost mercury is charged with gold, which is therefore also lost. That some amalgam passes the aprons and plated sluices is proved in the North Star mill, Nevada county, where Gauthier's shaking amalgam table saves $50 per day between the sluices and concentrators. In this case the greater part of this amalgam would most likely have been saved by the concentrators had not the shaking apron intervened, and, though the mercury would have been lost in the subsequent treatment of the headings by roasting and chlorination, the gold would have been saved, minus the loss that would accrue during that treatment; but aside from the fact that it is not desirable to have amalgam mixed with the concentrates for treatment by chlorination, there are many cases in which concentrators are not used. In such cases the loss of $50 per day would not be insignificant in any mill. It is generally supposed by mill men that if they find but little amalgam or none on their lower plates they are saving all the gold, or at least the loss is infinitesimal. That this may be an erroneous supposition is shown by the fact that the Spanish mill amalgam is collected on the lower portion of the "tail plates" when none is found near the upper end, and a significant circumstance is that it is collected at a point where a curve is formed by reducing the pitch of the plates. The effect of the curve in the plates is worth attention. Mr. Tregidgo and others have found by direct experiment that a curved plate collects more gold than a flat one, and that a convexity is better than a concavity. That which collects gold will also be likely to collect amalgam and mercury. In the Plumas-Eureka mill 76 pounds of mercury are lost in working 4,600 tons of ore. The proportion of gold contained by dry amalgam varies with the degree of comminution of the gold from one-half to one-fifth. If we admit that the mercury is lost in the form of a dry amalgam, containing one-fifth of its weight of gold, the above quantity represents 95 pounds of amalgam, containing 19 pounds of gold, which, with 14.58 troy ounces to the pound, at $14 per ounce, would give a value of $3,878.28 to 4,600 tons of ore, or 84.31 cents per ton. However, it may be conceded that not all of the lost mercury is in the form of dry amalgam.

As to the causes of the loss of mercury, it may well be supposed that a portion of that loss is due to ordinary wear; that is, that the metal is, to a slight extent, subject to attrition by sand and water, the result being a quicksilver dust of such extreme fineness as to be incapable of being recovered. Another portion is lost by handling, by adherence to the fingers of workmen, by splashing when poured, etc., and it is quite possible that a little may become oxidized or combined with sulphur or other mineral matter from the ore. Some undoubtedly evaporates at ordinary temperatures, though in scarcely appreciable quantities. In the process of retorting the amalgam there may be a failure to expel quite all of the quicksilver, a portion remaining with the gold, and not all that is expelled is condensed and collected, as at the Keystone mill, where 10 ounces monthly are thus lost. Another way in which some quicksilver may be lost in gold mills, as it certainly is in silver mills, is by adherence to metallic particles which are attached to the gangue. In this case it is the gold that steals the quicksilver, instead of the reverse. The discovery of the cause and the prevention of undue oxidation of the plates will obviate one important source of loss of amalgam. Frequent removal of the amalgam from the mortars seems to be beneficial, and the common practice of running for a month, or until the shoes and dies are worn out, before cleaning up appears to be bad. Therefore, on account of the waste of amalgam by abrasion or extreme comminution, it might be found profitable to clean the batteries, at least partially, every two or three days, notwithstanding the loss of a little time in so doing.

As a substitute for silver plating, some mill men smear the amalgamated plate with silver amalgam. There is some diversity of opinion and practice in the matter of preparing the copper plates when not silvered, and some operators think they have processes of unequaled efficacy. It makes no difference as to how the mercury is induced to attach itself to the plate, unless it may be in the expense, provided the amalgamation is thorough, and that any chemicals used in the process are afterward completely removed by washing. An efficient way in which to amalgamate a plate is first to clean the surface thoroughly by pouring on it nitric acid of such strength as to "bite" promptly and effectively, then wash repeatedly with clean water; next pour on a solution of corrosive sublimate, which will cover the entire surface with a slight film of mercury, again wash, and then, on pouring quicksilver upon the plate, it will spread over the entire surface with the greatest facility; even a film of oil on the plate can not prevent the spreading or adhering. A method preferred by some, though more laborious, is to scour the plate with sand until it presents a bright, clean surface, afterward rubbing it with quicksilver and solution of cyanide of potassium. Others prime the plate by means of a solution of mercury in nitric acid, following that with metallic mercury.

It does not require any great skill to amalgamate copper plates, but to keep them always bright and active while in use is more difficult. What seems, however, to be a good plan is to anneal a new plate before amalgamating it. This softens the hard film produced by the rolling mill and leaves the plate in a better condition for catching the gold on its surface.

There is in most gold mills a want of intelligent adaptation of means to the end sought in amalgamation. The finer particles of gold are those which are the more liable to be carried away in suspension, and which consequently require the greatest feasible exposure to the possibility of contact with the amalgamated surface of the plate. The coarse gold is amalgamated in the battery. The coarser of those particles which are thrown out of the mortar by violent agitation of the water within are readily arrested on the apron. What, then, is the object of the plated sluices through which the pulp is afterwards conducted? Manifestly it is to save those finer particles which continue to move with the current. Is it, then, philosophical to increase the violence of that current by restricting it to a narrower channel, which is done in almost every instance, the aprons having a width of from 4 to 5 feet, while the plated sluices are only from 14 to 16 inches wide? If the sluice was turned sidewise to the stream, the plates curved as a segment of a cylinder, and the pulp spread over a width of 12 feet instead of 16 inches, and at the same time suitably diluted with clean water, it would probably deposit more of the suspended gold in the 16 inches of traverse across the plate than it now does while rushing through the 12 feet of length with only 16 inches of breadth. The principle has been demonstrated to be correct by actual experiment.

There is a manifest tendency toward an increased use of wire-gauze screens in wet crushing mills in some parts of the state. It has often been asserted, and is perhaps generally believed, that brass-wire screens can not be used with quicksilver in the battery, and for this reason screens of that character have been left generally to the silver mills, while even they have more commonly used punched screens for wet work. The general idea is that the brass will become amalgamated, and that first choking and then destruction of the screen will ensue; but this does not seem to be the case, which will not greatly surprise any one who has tried to amalgamate brass without using some kind of chemical to induce adherence of the mercury. With some ores, especially those which contain zinc blende, the brass screens have been known to become amalgamated in 12 hours without the use of chemicals in the battery.

Screens made of common tin plate, punched in the usual manner, are being used to the astonishment of many who had supposed that the mercury would lay hold of the tinned surface and cause choking of the screen, whereas, in fact, the special merit claimed for the tin screens by those who use them is freedom from choking, which may be due to the thinness of the plates. Tin screens are used in Amador county by one or two mills. The tin is burned off previous to using. They do not last long, but the old screens, having some little gold attached, are returned for new ones, pound for pound, and they are found to discharge well. In many, if not in all, of the best gold-quartz mills the screens are not more than 8 inches high, often not more than 6 inches, and experience proves that this is ample, and that the old style of from 14 to 16 inches high has no advantage over the present. As to placing the screens vertically, or with a slight inclination outward, it seems to make no appreciable difference.

In batteries the tendency is toward heavy stamps, some of the new mills having them of 1,100 pounds weight, while 1,000-pound stamps in some sections are becoming quite common. Another change is the increasing substitution of riffles for inside plates. The riffles are cast on an iron back plate, which is fixed in the mortars, and are said to catch a great portion of the amalgam. Steel shoes and dies are usually considered more economical than iron, and are being more generally used than formerly. In some California mills, as well as in the Silver King mill, in Arizona, it has been found that the steel dies become worn in holes, and so irregularly as to be rendered useless long before they are worn down to the requisite size for abandonment, while the shoes remained in excellent form. In these cast-iron dies were used with steel shoes very advantageously. The inference to be drawn from this irregularity of the wearing of the dies is that the material of which they were made was of a bad quality. It is commonly stated at the mills where steel is used that the shoes and dies of eastern make are much superior to those made in California, and at the Plumas-Eureka mill the English article is declared to be better than either of the others.

Tappets and cams of steel are now becoming common, and give great satisfaction. The tappets are generally counterbored, and this practice is also being applied, though less generally as yet, to cams. The effect of the counterbore is to give the cam or tappet three points of contact with the shaft instead of only two, as when the core is circular, the counterbore being slightly oval, with the longer axis passing through the key seat in the cam or the gib in the tappet. This gives greater stability by preventing oscillation or wabbling.

In regard to the weight of the stamp, it must be remarked that the nominal weight, as given at the foundries, is greater than the actual weight. The former is the gross weight, the latter the net weight, of the finished stamp, including stem, boss, and shoe. The difference may be 50 pounds, by which amount the reported weight must be reduced in general. Unfortunately the most advantageous weight of stamps for crushing gold quartz can not be deduced from a comparison of the stamp duties in the different mills, because the stamp duty is a function of many different quantities. The hardness of quartz, as tested by scratching, is nearly uniform; but the facility with which it may be crushed depends greatly on its texture, as whether it is friable, like that of the Yuba mine, or compact. The size of the lumps of ore falling under the stamps exercises an important influence on the stamp duty, for, while a large piece manifestly requires more force to crush it than a small piece, it unfortunately happens in a battery that the larger the piece the less force is applied, because the drop of the stamp is proportionately reduced at the time when it should be increased. For the same reason the manner of feeding makes a great difference, high feed taking more from the fall of the stamps than low feed.

Naturally, the more the rock is broken into small pieces before it goes to the battery the lower and more uniform can the feed be made and the less drop will the stamps require; hence the frequency of the drops can be increased, and more ore can be crushed with the expenditure of a given amount of power in lifting the stamps. At the Silver King mill, in Arizona, the stamp duty with a given drop was increased fully 20 per cent by the use of a good rock breaker, as compared with the results of breaking by means of hand hammers. Then not only the grade of screen used, but the height of the discharge above the dies, the width of the mortar, the extent and rate of stamp drop, the quantity of water used in the battery, the proportion of the sulphurets, all influence the rate of crushing, even though the ore may be essentially quartz, and when different kinds of rock also enter into the question it becomes so much the more involved.

In the Delhi mill stamps of different weight are used, namely, 1,000 pounds and 1,100 pounds, the screens and drops being equal. This would afford a good basis for comparison but for certain circumstances. In the first place, the diameters of the shoes are not proportioned in the ratio of the weights, being, respectively, 9 and 10 inches, giving the crushing surface ratios as 81 to 100, while the weight ratios are as 90 to 100. In the second place, the heavier stamps are 5 in battery, while the lighter are but 4, which places the latter at a disadvantage in two ways: first, because the order of the drops can not be so well arranged, in consequence of which 2 adjacent stamps follow each other, which is a disadvantage; second, because one-half of the 4 stamps are necessarily end stamps, while in the other case only two-fifths are end stamps, and it is conceded that the end stamps do less crushing than the others in a mortar. Thus the statement of the mill foreman that the 5-stamp batteries crush one-half ton per stamp a day more than the 4-stamp batteries, while doubtless true, can not be accepted as proof of the superiority of the heavier stamps, which consume less power in proportion to the work done; that is, they require one-tenth more power and do one-fifth more work, nearly.

The Blue Bell and Washington mills, in Nevada county, are alike in weight of stamps, drop, number of drops, and grade of screens, yet the respective stamp duties are 1.7 and 2.2 tons, while the Yuba, with 50 pounds more weight of stamp, 1.25 inch more drop, and 4 less to the minute, has a duty of 2 tons. The power required for the Blue Bell and Washington is to that required by the Yuba as 4,399 to 5,418, while the mean duty of the first two is to the mean duty of the last as 195 through 30 meshes to the inch to 200 through 40 meshes. The additional power consumed in the Yuba, equal to nearly 23 per cent, gives nearly 2.7 per cent more ore crushed through a sieve which has nearly 78 per cent more meshes to the square inch. The value of the difference it is impossible to compute in terms of power required, hence this comparison is of little utility.

The Gaston Ridge mill, with 750-pound stamps, consuming a power represented by 58, has a duty of 2.75 tons daily, while the Omaha, with 900-pound stamps and a power consumption represented by 50, gives a duty of 1.6 tons daily, the screens being of the same grade in both. In this case the lighter stamp consumes the greater amount of power, owing to the higher and more frequent drop, and it crushes nearly 72 per cent more ore with 16 per cent more power, which is largely in favor of the lighter stamps. Again, the Mayflower, with 950-pound stamps and a power in the proportion of 59, crushes 2.5 tons through the same screen; hence, with slightly less power, the lighter stamp again crushes more than the heavier by 10 per cent.

Comparing the mean results of the Blue Bell and Washington with the results of the Crown Point, we have:

Weight of stamps .......... 850 pounds; power, 44; duty, 1.95
Weight of stamps .......... 750 pounds; power, 45; duty, 1.50

As the screen is the same, the result is in favor of the heavier stamp.

The following are the results of some calculations of the proportionate power required to crush 1 ton of ore in different mills. The proportional power is found in this way: The nominal weight of the stamp is corrected by the subtraction of 50 pounds for trimming and mean wear. The stated drop is reduced by 1 inch to allow for the loss of drop by the ore under it. The corrected quantities are then multiplied together, and the product is multiplied by the number of drops per minute. This product divided by the stated stamp duty gives a relative figure representing the power used in lifting the stamps.

PROPORTIONAL POWER REQUIRED TO CRUSH ONE TON OF ORE AT VARIOUS CALIFORNIA MILLS.

| SCREEN, NO. 9 SLOT. | | SCREEN, NO. 7 SLOT. | | SCREEN, NO. 6 SLOT. | | SCREEN, NO. 5 SLOT. | |
|---|---|---|---|---|---|---|---|
| Nominal weight of stamp. (Pounds.) | Proportional power to 1 ton. | Nominal weight of stamp. (Pounds.) | Proportional power to 1 ton. | Nominal weight of stamp. (Pounds.) | Proportional power to 1 ton. | Nominal weight of stamp. (Pounds.) | Proportional power to 1 ton. |
| 950 | 144 | 850 | 207 | 850 | 144 | 850 | 168 |
| 900 | 109 | 750 | 168 | 850 | 174 | 750 | 151 |
| 800 | 198 | 750 | 151 | 750 | 166 | | |
| 800 | 144 | | | | | | |
| 650 | 255 | | | | | | |

These results show the impossibility of deducing anything useful in this respect from the records of different mills working on different ores.

Of machines other than stamp batteries for the reduction of auriferous rocks the writer can say but little, unless as to the work at the Spanish mine, in Nevada county, where perhaps the lowest grade of milling rock that has ever been made profitable in this country is successfully worked in Huntington centrifugal rolling mills.

By reference to the notes on the mine in question in the report of the state mineralogist of California in 1888 it will be seen that the ore yields an average of 70 cents per ton, on which a profit of 20 cents per ton is realized. It goes without saying that the conditions are exceptionally favorable for extracting and milling the ore at little cost, and that a cheap class of labor is mainly employed; yet one must admire the courage of the man who not only undertakes to handle 70-cent ore without loss, but has actually paid off some $8,000 of debts from the proceeds. In this plant the 5-foot Huntington mills work daily some 35 tons each of soft slate mixed with a little ferruginous quartz. It must not be hastily inferred that this mill is suitable in all cases.

The Tustin mills have worked satisfactorily in Calaveras county, at the Willard mine, where they have been used for crushing ore for amalgamation on plates and concentration of the sulphurets. Mr. T. B. Morse, E. M., in his report on this mine, published in the report of the state mineralogist of California for 1886, speaks of the work of this machine, in comparison with stamps, as follows:

> A comparison of the two methods of crushing shows a marked difference in the results. In crushing through the battery a large amount of slimes is produced; with the pulverizer a very small quantity of slimes is made. As a consequence, with ore where the rock is very hard, the gold exceedingly fine, and the sulphurets soft and brittle, it is found that on the same ore a much greater percentage of the fine gold is amalgamated after the pulvervizers than after the stamps, and in concentrating only 18 to 20 per cent of the assay value of the ore can be saved after stamps and 85 per cent after the pulverizers. On the same ore and with the same screen 1 pulverizer is about the equivalent of 6 to 8 stamps, according to the character of the ore.

This verifies what has been said as to some of the causes of loss of gold and of sulphurets.

Another machine is Kendall's national rocker. A mill of this kind is worked at Bald Hill, in Placer county, and Mr. Bell, the owner, states it is giving excellent results from hard quartz containing free gold and pyrites. It was also tried at the Spanish mine, and although not so satisfactory as the Huntington, it did as well as a stamp battery. The Wiswell and Bryant mills, which are modifications of the well-known Chili mill, or edge wheel, are well spoken of in some quarters. All these mills are essentially rolls, differing from the Cornish and Krom rolls chiefly in that they consist of a roller or rollers working against a plane, or a ring-formed base, instead of against another roller, with the advantage that the ore does not escape until it is fine enough, while, especially in the Tustin pulverizer, it is not subjected to much needless trituration. It is well known that they produce less slime than batteries do, and crush the ore with more evenness. While stamps may be best in many cases, it may well be that some of our mill men go too far in giving them the preference in all.

It has been shown that one cause of a loss of gold may be excessive trituration in the battery. One of the radical defects of the battery is that the rock is not completely expelled from the mortar as it becomes fine enough to pass the screen. It would be easy to demonstrate that it can not be, but that is unnecessary, as the point is universally conceded. On the other hand, a loss, more or less, is always sustained for the want of trituration of a portion of the ore, leaving many particles of gold still inclosed in the stone. The notes in the report show a very general preference for the Frue concentrator; nevertheless, where the Frue and Triumph are used side by side in the same mill there seems to be no difference in the results obtained, though preference is still given to the Frue, for the reason, as stated by the mill men, that it requires less care and attention than the other, which is to say equally good results are obtained with less trouble. How far the preference may be due to the fact that the Frue was first in the field the future must determine.

As a motor, where water power under high fall is available, the practical verdict of the mill men is in favor of the Pelton wheel.

In Amador county, California, more Knight wheels are used than Pelton, and as many Donnelly as Pelton. Knights are generally used in hoisting works, on account of the hydraulic nozzle. With 2 6-foot Knight wheels and power gates and nozzles the engineer can run the cable 400 feet per minute and stop the skip within a foot from the place it occupied when the gate was closed. These nozzles do not work in a bucket shaped like the Pelton. The Pelton wheels under most heads work to a higher percentage. The Donnelly wheel is used with any number of round nozzles. The buckets are fastened on the wheel, as in the case of the Pelton. Overshot wheels are rather frequently used with low falls, but are open to the objection of a great tendency to become loaded with ice in cold weather; moreover, a Pelton will work with a low fall, and is cheaper than an overshot of large diameter. The true turbine wheels are not much used in quartz mills, probably because a turbine for high fall is of very small diameter, and consequently must make so many revolutions per minute that excessive "gearing down" is necessary in order to obtain the very moderate rate of revolution required in most parts of a rock mill, which is not the case with a Pelton, a Knight, or a Donnelly, as these can be made of much larger diameter for any given fall, and hence make fewer revolutions per minute. Another difficulty with at least one of the best turbines is that, if not worked at full gate, any suspended matter in the water, even mica, lodges in the wheel case and obstructs the movement of the gates when that becomes necessary; also, the efficiency of such wheels is much impaired by a small amount of wear.

The feeders in use, where not some simple home-made contrivance, as the "box feeder", or the more ingenious "bucket-roller" feeder in the Ready Relief mill, are almost universally the Hendy Challenge. The Templeton or roller feeder is used exclusively in the Keystone mill, and is giving entire satisfaction, and the same feeder in the Bunker Hill mill works side by side with the Challenge, and though the latter is considered the better machine, it is much more costly.

The writer has examined a sample of concentrated sulphurets as to an alleged volatilization of gold in roasting them in the muffle without salt. The sender stated that he found a loss of $22 in gold and 2 ounces of silver to the ton. Two assays were made on the raw material with very nearly concordant results, and two others were carefully roasted prior to the smelting, the results of these also nearly agreeing. The difference between the means of the raw and the roasted assays showed a loss of 0.3 ounce of silver per ton, or about 1.5 per cent of the total silver. There was no loss of gold. The ore contains, besides iron pyrites, tellurium and antimony; not any copper. In the experiment the ore was roasted with very low heat, and under a perforated cover to prevent loss by decrepitation, for about 45 minutes, being twice removed from the muffle, cooled, uncovered, and stirred. Afterward the covers were removed and the roasting was continued for half an hour longer under higher heat; the ore then smelled quite "sweet", and was assayed in the usual manner. The roasting dishes were well coated on the inside with reddle, and after the roasting the bottoms were scoured with ground glass to remove any metal which might have passed into or adhered to the substance of the dishes, the resulting dust being added to the assays. The losses noted by the sender must be ascribed to the decrepitation of the ore, too rapid roasting, or absorption into the dishes, or to all of these causes combined, neither of which, however, would have much effect in the roasting in a 3-hearth reverberatory furnace.

### CHLORINATION OF GOLD ORES.

The following in relation to the practical chlorination of gold ores by the barrel process and the precipitation of gold from solution was contributed by Mr. John E. Rothwell to the Engineering and Mining Journal, New York, February 7, 1891:

This is a record of actual, successful working experience on a large scale in 1890.

The chief objection to a plant of 50 tons or more capacity in 24 hours for the Plattner process is its enormous size and the length of time it requires to complete a single operation. Therefore, the problem the engineer has to solve in attempting to treat low-grade ores that will not concentrate is to find a process that will treat his ores in large quantities quickly, cheaply, and with as little interruption as possible. It may therefore be of interest to hear of one solution of this problem that has been demonstrated beyond a doubt. In the reduction works, of which this article treats in particular, the ore is crushed dry in Blake and Gates crushers and 2 sets of Krom rolls, roasted in Brückner furnaces of 3 tons capacity, and chlorinated in barrels of 3 and 4 tons capacity.

#### CRUSHING.

The first thing to be considered in treating an ore is to crush it properly. To do this a series of experiments has to be made to ascertain how coarse the ore may be to give the best result in the after treatment, with reference to economy, large capacity, and best extraction. The pulp for the best leaching must be in granular condition, and carry as small a percentage of dust or slimes as possible. For this purpose rolls properly managed are especially well adapted. A few lessons from experience with rolls may not be out of place here. The chief point is to have enough of them to make the reduction in size of particles passed through them gradual. 2 sets are sufficient, but 3 will do better. The ore should come to the coarse rolls not coarser than three-fourths inch mesh, and these rolls should be set about three-eighths inch apart. The middle rolls are set about three-sixteenths inch or less apart, and the fine rolls about as far apart as the size to which the ore has to be crushed. If only 2 sets are used, the coarse are set a little closer than with 3, and the fine remain the same. The springs should be set up so tight that they will not give to the hardest pieces of ore, but will allow a piece of steel or iron to pass through without throwing the belts. The periphery speed of the rolls should be about the same as or a little faster than the falling speed of the ore, and the ore should be fed in an even sheet across the surface of the roll. Little trouble will then be experienced in keeping the surfaces true and in producing a granular pulp carrying but a small percentage of dust. If rolls were made of larger diameter and narrower, the result would be a still more gradual reduction, and possibly a greater capacity. The writer has used those of 39.5 inches (1 meter) diameter and 12 and 15 inches face.

#### ROASTING.

The roasting of the ore is one of the most important operations in its influence on the success of chlorination, but as the characteristics of each ore must be studied, none but general rules can be laid down as to how roasting should be done. It is absolutely necessary that the ore be roasted as nearly dead sweet as possible.

#### CHLORINATION.

The chlorination barrel in the works of which the writer has charge is made also the washing and leaching vessel. This is done by placing a supporting diaphragm, for a filtering medium, to form the chord of an arc of the circle of the barrel. The diaphragm, or "filter", as it is called, is made up of plates, corrugated similar to the ordinary filter-press plate, and perforated with holes every 4 or 6 inches square. These plates are supported on segments, which are bolted to the shell. On top of the corrugated plates is placed the filtering medium, an open-woven asbestos cloth. It is about as coarse as the ordinary gunnysack, but the warp and woof are of much heavier thread. Over this is placed an open grating, and the whole is held in place by cross pieces, the ends of which rest under straps bolted to the inside shell. In this way, while the whole is rigidly held in place, it is very easily and quickly removed when the changing of the asbestos cloth becomes necessary. 2 valves on each end of the barrel, above and below the filter, are for the inlet and outlet of the wash water and solution, respectively. The barrel is charged by first filling the space under the filter with water, which at the same time is allowed to pass through the filtering medium and wash it; then the required quantity of water is put in above the filter. There are now two methods of charging the pulp and the chemicals, lime chloride and sulphuric acid. In one the lime is so placed in the ore charge in the hopper over the barrel that it goes in with the ore and is completely buried with it. The acid can then be added with very little danger of generating any gas before the plate on the charging hole can be put on and securely fastened. The other way, which seems to be still better, is to pour the acid first into the water, through which it sinks in a mass to the bottom and does not mix. The ore is then let in, and the lime added the last. The chances of generating any gas are much less than in the first method. A barrel charged in this way has been known to remain open for from 5 to 10 minutes after charging without generating gas, but it has been demonstrated that on the first revolution of the barrel the gas is immediately liberated, and creates considerable pressure. After the chlorination is complete the barrel is stopped, so that the filter assumes a horizontal position. The hose is attached to one of the outlet pipes and conducts the solution to the reservoir tank. A hose is also attached to the inlet pipe, and water is pumped in under pressure, and the leaching commences. The air in the top part of the barrel is compressed and forms an elastic cushion, which gives the wash water perfect freedom to circulate evenly over the whole surface of the charge and wash every portion of it thoroughly and with the smallest quantity of water possible. By washing in this manner no gas is allowed to escape into the building. The solution runs into a covered reservoir tank, from which an exhaust fan draws the excess of gas and discharges it outside the building. The length of time required to do the leaching varies with the leaching quality of the ore treated, charges having been leached in 40 minutes with a pressure of from 30 to 40 pounds per square inch. With higher pressures the time can be materially shortened. As can readily be seen, the ore in the barrel is in the best possible shape for rapid and perfect leaching. When the barrel is stopped the ore settles on the filter, the coarsest and heaviest on the bottom and graduated evenly over the whole surface and up through the charge to the slimes on top. In order to facilitate the leaching of charges carrying an excess of dust or slimes, a valve placed in the casting of the head, on a level with the surface of the pulp, is opened just after the barrel is stopped, and the dust and slime which remains in suspension is run off into an outside washing filter press, where it can be treated separately, and the charge washed in the usual way. The tailings are discharged into a car which will hold the whole charge of ore and water, and then run out; or, if water is abundant, they are discharged into a sluice and washed away.

For leaching purposes the amount of water necessary to wash a charge varies very little with the richness of the ore, which goes to show the perfect leaching condition of the ore in the barrel. The amount required is about 120 gallons per ton more than the quantity used in the barrel for chlorination, which is about 100 gallons per ton.

In order to get a concentrated solution for after treatment and to reduce the amount of solution to be treated, also saving in water, a tank is placed above the barrel, and when the richest of the solution and wash water has run out into the reservoir tank the discharge hose is connected with the pipe leading to the upper tank, and the washing is finished into it. The solution collected in this way is used in the next following charge in the barrel. The quantity of solution to be precipitated is thus reduced to about 120 gallons per ton of ore treated.

The advantages of this method of treating ores are many, among which may be cited the small amount of labor, and especially of skilled labor, necessary; the freedom of the building from chlorine gas; the control one has over the perfect washing of the charge; the small amount and simplicity of the machinery for the great amount of work accomplished. One man of ordinary intelligence and a helper are able to take care of 3 barrels; that is, look after the charging, leaching, and discharging. If the tailings are sluiced out, they can also attend to it; but where they have to be trammed out one more man is necessary. The disadvantages are due to the construction necessary, but do not interfere in any way with the successful working of the barrel. They are principally the amount of space taken up by the filter and the portion of the barrel under the filter, and the fact that when the barrel is charged and running it is not in a perfectly balanced condition. These disadvantages can be overcome to a great extent by a little different construction. By using a filter placed close to the shell, only space enough being left between it and the shell to allow of free circulation, and reaching to the same height on the sides as the horizontal filter, then by using compressed air to displace the solution and wash water, an equally good result could be had.

### PRECIPITATION.

For the collection of the solution 2 tanks are necessary, each of ample capacity to hold a day's solution from all the barrels. Those for collection are placed on the same floor as the chlorinators, or, where there is sufficient fall, on the floor below. Then on the floor below them are the precipitation tanks, which should be of the same capacity as the collecting tanks and the same in number. The limit to the size would probably be a 50-ton capacity. Where more is treated another battery of tanks would be necessary. For a precipitant the writer has found hydrogen-sulphide gas, generated from paraffin and sulphur or iron sulphide and sulphuric acid, to give the cheapest and most satisfactory results. It is generated and then forced through the solution with a small air pump, which at the same time forces air through and keeps the tank of solution in an agitated state and expels the free chlorine gas. In this way a precipitation can be made in a short time, and the precipitate is in a collected and flocculent form that settles quickly. To save time the gas is turned into the tank while this is filling up, so that when the tank is full a very few minutes finish the precipitation and collection. The tank is now allowed to stand for 2 or 3 hours, when it has settled sufficiently to draw the supernatant liquor off through a filter press. There is little danger of precipitating arsenic or antimony that may be in the solution when it is worked cold, as they do not commence to come down till some time after the gold has precipitated and collected. Of course any copper or lead in solution will be precipitated with the gold, which would not make this precipitant desirable where there is considerable of either metal in solution; but with small quantities they are easily taken care of in the after treatment. The loss in gold is considerably less if the precipitate is allowed to accumulate in the tanks and a clean up made after 6 or 10 precipitations than if it were filtered through a press and collected after every precipitation. There does not seem to be any advantage derived from a continuous precipitation and collection on this account if hydrogen-sulphide gas is used as the precipitant, as the filters will soon become so coated and clogged with the sulphides as to retard rapid filtration without extreme pressure, which is sure to increase the loss. The handling of a large number of filter cloths is also a source of loss, no matter how carefully it may be done. The same objection applies to all continuous precipitation schemes where large quantities of solution are handled.

The asbestos filter cloth can be changed in about an hour and a half, and under ordinary conditions will last for upward of 100 charges. One cloth has been known to last 150 charges, so that this objection to the filter inside the working barrel is really nil.

The life of the supporting plates and grating can be made to equal the life of the lining of the barrel, and that with barrels that have several thousand charges to their credit shows little signs of wear yet.

## CHEAP MINING AND MILLING IN 1888 AND 1889.

The following description of the work at the most economical gold mines and mills in the United States is put on record as showing the minimum costs attained at the date of the Eleventh Census, 1889:

The cost of working at the Spanish gold mine, California, has proved to be the lowest on record. While the mine is not operated on a large scale, it has the advantage of water power and of having soft ore at and near the surface and easily run into the mill. Taking the cost per ton for mining and milling together, this report makes the best record, and is in its way as remarkable as the famous run of the North Bloomfield hydraulic mine. The lowest mine cost per ton was 31.4 cents, and milling cost 20.8 cents, or 52.2 cents per ton total, in November, 1887. The highest total mine and mill cost per ton between September, 1887, and March, 1888, was 60.6 cents, and the monthly returns were pretty regular. Even at these rates the margin for profit is not large.

The following information was furnished to the Engineering and Mining Journal, May 5, 1888, by Mr. F. W. Bradley, the lessee of the mine:

Ore can be handled here cheaply because the mining is in a large deposit of soft slate that crops out from 30 to 100 feet in width on the face of a steep mountain. This slate is seamed in every direction by small stringers of quartz. There is a little gold in the slate, some in the quartz, and considerable in a loose free state in the clay parting between the quartz and the slate. The formation has a pitch of about 80 degrees from the horizontal. When the weather permits, the mining is done in open cuts on the croppings over the main working tunnel, which starts from the surface immediately at the top of the mill building and follows the course of the deposit into the mountain. During stormy weather ore is obtained from accumulated supplies and by stoping the best portions of the deposit over the tunnel and replacing the same by square sets of timber in such a manner as to form ore bins for storing and loading into the tunnel cars ore broken in the cuts. In the cuts the softest streak near the foot wall is stoped by Chinese miners. Ore left on the foot wall soon slacks off and ore on the hanging wall and also portions of the hanging wall cave in. All waste is separated as much as possible from the ore and left in the worked-out cuts, there being a strong pillar left at the end of each cut. The tunnel has a grade of 2.5 inches to 16 feet. A brake on the last car controls a train of 10 loaded cars coming out, and a mule easily hauls back the empty train.

MILLING PLANT AT THE SPANISH MINE.

| | |
|---|---|
| 4 Huntington mills and self-feeders | $6,346.22 |
| Labor, setting up and building | 2,304.83 |
| Silver-plated amalgamating plates | 1,985.35 |
| Water pipe and wheel, shafting, and pulleys | 1,220.75 |
| Lumber, building, and V flume | 1,194.52 |
| Hardware | 1,026.08 |
| Blake crusher | 618.45 |
| Cost of milling plant under cover and running | 14,696.20 |

Freight, $24 per ton from San Francisco; lumber, $22.50 per thousand.

The mills crush from 120 to 140 tons per day, depending upon the proportion of quartz in the ore. Amalgamation is done inside the mills, obtaining 45 per cent of the gold saved around and inside the mills and 55 per cent on the plates. The tailings are not touched after leaving the plates. One ounce of quicksilver is lost for 16 to 31 tons of ore crushed, depending upon its value.

In experimenting with screens, a No. 6 slot was used for a long time, but was finally replaced by a No. 5.

The Huntington mill is peculiarly adapted for working this ore, and with stamps the mine would not pay.

In the first 10 months 1 5-foot mill and 1 4-foot mill crushed 17,200 tons of ore. 2 5-foot mills were then added to the plant. Since then the 4 mills have crushed 19,402 tons. The ore, of which 27 cubic feet is called a ton, consists of about one-third hard quartz, one-third tough slate, and one-third decomposed quartz and slate. The 4 mills require 22 horse power, are run at 60 revolutions per minute, and discharge through a No. 6 slot screen. During the last 4 months the mills have averaged 136 tons of ore per day.

RESULTS AT THE SPANISH MINE, NEVADA COUNTY, CALIFORNIA, IN 1888 AND 1889.

| ITEMS. | SEPTEMBER. | | | | OCTOBER. | | | |
|---|---|---|---|---|---|---|---|---|
| | 22 days, 2,796 tons of ore. | | | | 28 days, 3,443 tons of ore. | | | |
| | Total. | Labor. | Supplies. | Per ton. | Total. | Labor. | Supplies. | Per ton. |
| MINE. | | | | | | | | |
| Mining | $572.32 | $486.59 | $85.73 | $0.21 | $816.91 | $703.50 | $113.41 | $0.24 |
| Dead work | 280.30 | 237.30 | 43.00 | 0.10 | 116.13 | 105.20 | 10.93 | 0.04 |
| Delivering ore to mill | 136.70 | 126.00 | 10.70 | 0.05 | 178.15 | 160.20 | 17.95 | 0.05 |
| General expenses | 61.82 | 58.22 | 3.60 | 0.02 | 80.30 | 78.35 | 1.95 | 0.02 |
| Total | 1,051.14 | 908.11 | 143.03 | 0.38 | 1,191.49 | 1,047.25 | 144.24 | 0.35 |
| Cost per ton | 0.38 | 0.33 | 0.05 | ........ | 0.35 | 0.31 | 0.04 | ........ |
| MILL. | 20 days, 2,796 tons of ore. | | | | 24.5 days, 3,443 tons of ore. | | | |
| Mill expenses | 306.55 | 163.45 | 143.10 | 0.11 | 421.65 | 227.32 | 194.33 | 0.12 |
| Water for power | 152.20 | ........ | 152.20 | 0.05 | 161.70 | ........ | 161.70 | 0.05 |
| Handling ore | 124.46 | 121.50 | 2.96 | 0.05 | 159.85 | 154.50 | 5.35 | 0.05 |
| General expenses | 61.53 | 58.23 | 3.30 | 0.02 | 80.35 | 78.40 | 1.95 | 0.02 |
| Total | 644.74 | 343.18 | 301.56 | 0 23 | 823.55 | 460.22 | 363.33 | 0.24 |
| Cost per ton | 0.23 | 0.12 | 0.11 | ........ | 0.24 | 0.13 | 0.11 | ........ |
| Bullion produced | 3,268.49 | ........ | ........ | 1.17 | 3,138.55 | ........ | ........ | 0.91 |
| Total expenses | 1,695.88 | ........ | ........ | 0.61 | 2,015.04 | ........ | ........ | 0.50 |
| Profit | 1,572.61 | ........ | ........ | 0.56 | 1,123.51 | ........ | ........ | 0.32 |

RESULTS AT THE SPANISH MINE, NEVADA COUNTY, CALIFORNIA, IN 1888 AND 1889—Continued.

| ITEMS. | NOVEMBER. | | | | DECEMBER. | | | | JANUARY AND FEBRUARY. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30 days, 4,047 tons of ore. | | | | 25 days, 2,972 tons of ore. | | | | 36 days, 4,256 tons of ore. | | | |
| | Total. | Labor. | Supplies. | Per ton. | Total. | Labor. | Supplies. | Per ton. | Total. | Labor. | Supplies. | Per ton. |
| MINE. | | | | | | | | | | | | |
| Mining | $876.28 | $679.63 | $196.65 | $0.21 | $559.84 | $458.64 | $101.20 | $0.19 | $515.37 | $374.18 | $141.19 | $0.12 |
| Dead work | 115.25 | 100.90 | 14.35 | 0.03 | 250.51 | 230.22 | 20.29 | 0.08 | 481.53 | 434.23 | 47.30 | 0.12 |
| Delivering ore to mill | 206.94 | 193.25 | 13.69 | 0.05 | 211.19 | 189.75 | 21.44 | 0.07 | 262.85 | 239.85 | 23.00 | 0.06 |
| General expenses | 75.45 | 70.70 | 4.75 | 0.02 | 72.50 | 69.26 | 3.24 | 0.03 | 127.94 | 121.26 | 6.68 | 0.03 |
| Total | 1,273.92 | 1,044.48 | 229.44 | 0.31 | 1,094.04 | 947.87 | 146.17 | 0.37 | 1,387.69 | 1,169.52 | 218.17 | 0.33 |
| Cost per ton | 0.31 | 0.26 | 0.05 | .......... | 0.37 | 0.32 | 0.05 | .......... | 0.33 | 0.28 | 0.05 | .......... |
| MILL. | 29 days, 4,047 tons of ore. | | | | 23 days, 2,972 tons of ore. | | | | 32 days, 4,256 tons of ore. | | | |
| Mill expenses | 388.49 | 225.67 | 162.82 | 0.10 | 336.02 | 175.26 | 160.76 | 0.11 | 481.76 | 239.49 | 242.27 | 0.11 |
| Water for power | 203.00 | 5.00 | 198.00 | 0.05 | 143.00 | 5.00 | 138.00 | 0.05 | 206.00 | 5.00 | 201.00 | 0.05 |
| Handling ore | 179.40 | 177.00 | 2.40 | 0.04 | 155.49 | 152.25 | 3.24 | 0.05 | 205.62 | 204.00 | 1.62 | 0.05 |
| General expenses | 75.46 | 70.71 | 4.75 | 0.02 | 72.50 | 69.26 | 3.24 | 0.03 | 127.92 | 121.25 | 6.67 | 0.03 |
| Total | 846.35 | 478.38 | 367.97 | 0.21 | 707.01 | 401.77 | 305.24 | 0.24 | 1,021.30 | 569.74 | 451.56 | 0.24 |
| Cost per ton | 0.21 | 0.12 | 0.09 | .......... | 0.24 | 0.14 | 0.10 | .......... | 0.24 | 0.13 | 0.11 | .......... |
| Bullion produced | 2,644.57 | .......... | .......... | 0.65 | 1,950.85 | .......... | .......... | 0.66 | 2,783.49 | .......... | .......... | 0.65 |
| Total expenses | 2,120.27 | .......... | .......... | 0.52 | 1,801.05 | .......... | .......... | 0.61 | 2,408.99 | .......... | .......... | 0.57 |
| Profit | 524.30 | .......... | .......... | 0.13 | 149.80 | .......... | .......... | 0.05 | 374.50 | .......... | .......... | 0.08 |

## LOW COST OF MINING AND MILLING AT THE DALMATIA MINE, ELDORADO COUNTY, CALIFORNIA, IN 1890.

[From the Engineering and Mining Journal, December 6, 1890.]

The Dalmatia mine is owned by an English company and is managed by Mr. George Cullen Pearson. The mine is located on the summit of a broad ridge between Rock creek and the South Fork of the American river, three-quarters of a mile east of Kelsey. It contains a wide belt of chloritic or a fine amphibolitic schist inclosed in clay slate. This belt is greatly decomposed and filled with a great number of quartz seams carrying gold. The width of this auriferous zone is not exactly known, but a tunnel cutting across it about 150 feet below the croppings has shown it to be more than 130 feet. The whole mass of reddish decomposed rock and quartz is mined. It carries on an average from $1.50 to $2 per ton. The ore is quarried in a wide, open pit at the croppings and dumped down to the tunnel level through several roomy chutes. At the mouth of the tunnel, which is about 300 feet long, the mill is situated. The cars dump the ore over a grizzly down to the level of the rock breaker. The machinery consists of 3 Huntington mills, doing excellent work on the soft ore, a 10-stamp battery, and a rock breaker. The ore carries but little sulphurets, and these of a character hardly worth saving. The capacity of this plant is somewhat over 100 tons per day of 24 hours, say about 3,500 tons per month. The power station is situated at the mouth of Rock creek, 1,200 feet below the mill and 2 miles distant. A ditch owned by the company conducts the water of Rock creek half a mile above the mouth. At the station it has a head of 110 feet. It is drafted through a 5.5-inch nozzle to an 8-foot Pelton wheel giving 100 revolutions. 130 horse power is developed. The generator is a 100 horse power Brush dynamo with 900 revolutions per minute. The current is conducted to the mill and returned by means of a copper wire, No. 3, Brown & Sharp gauge. A 60 horse power Brush motor receives the current at the mill, and, running at 800 revolutions, transmits the power to the countershaft of the mill. The efficiency of the Pelton wheel is stated to be 86 per cent. The loss in conducting the current through the wire for 2 miles, measured by volts and amperes at the power station and at the mill, is about 10 per cent. The actual amount of horse power furnished at the countershaft of the mill as compared to that furnished at the shaft of the generator, that is, the efficiency of the whole electric plant, is not known at present and can only be ascertained by dynamometric measurements, but the probability is that it does not exceed 60 or 65 per cent. Besides producing electricity for motive power the generator runs incandescent lamps for lighting the mill. The plant was erected in the spring of 1890, the work being greatly retarded by the rainy weather and bad roads. It has been in continuous operation for about 5 months. The operating expenses of the whole plant are surprisingly small. The ore of the Dalmatia is mined and milled for 50 cents per ton. The mining is done by contract, the price per ton being 7.5 cents. The remaining 42.5 cents represents milling, management, and amortization of capital.

# COPPER.

BY CHARLES KIRCHHOFF

Since the census year 1880 the United States has risen to the rank of the largest copper producer in the world, outstripping by far any other country. During the decade Arizona and, later, Montana have become important producing states, the latter having acquired and now maintaining rank as the leader. While by far the greater part of the metal produced is obtained from ores carrying only the baser metal, important quantities in the aggregate are derived from ores in which lead, gold, and silver are the principal constituents of value. These quantities are difficult to trace to their source. The ores are purchased by lead and copper smelters in the open market, often in small parcels, indirectly, through sampling works. Sometimes copper is not even present in the original ore in marketable quantity, and becomes a factor only when it appears in a concentrated form in the mattes of lead smelters and refiners.

The copper product of the United States in the calendar year 1889 was as follows:

| | POUNDS. |
|---|---|
| Arizona | 31, 586, 185 |
| Michigan | 87, 455, 675 |
| Montana | 98, 222, 444 |
| New Mexico | 3, 686, 137 |
| Colorado | 1, 170, 053 |
| Idaho | 156, 490 |
| Nevada | 26, 420 |
| Utah | 65, 467 |
| California | 151, 505 |
| Wyoming | 100, 000 |
| Vermont | 72, 000 |
| Southern states | 18, 144 |
| Lead smelters and refiners | 3, 345, 442 |
| Total | 226, 055, 962 |

These figures include the quantities of copper reported as an incidental constituent of other ores.

## COPPER MINING IN THE PRINCIPAL PRODUCING STATES IN 1889.

The details of the copper mining of the principal producing states during the year 1889 are given in the following tables, not including those mines fairly to be considered as precious metal mines:

### PRODUCTION.

| STATES AND TERRITORIES. | Ore produced. (Short tons.) | Mineral. (Pounds.) | Black copper. (Pounds.) | Matte. (Pounds.) | Fine copper contents. (Pounds.) |
|---|---|---|---|---|---|
| Total | 3, 322, 742 | 117, 804, 926 | 39, 713, 237 | 159, 547, 390 | 220, 569, 438 |
| Michigan | 2, 433, 733 | 117, 804, 926 | | | 87, 455, 675 |
| Montana | 698, 837 | | 10, 176, 744 | 147, 800, 590 | 97, 868, 064 |
| Arizona | 155, 586 | | 29, 532, 493 | 4, 126, 000 | 31, 362, 685 |
| New Mexico | 34, 586 | | 4, 000 | 7, 620, 800 | [a]3, 883, 014 |

[a] The apparent discrepancy between this amount and the amount entered in the above table of copper product is due to the fact that there is included in the larger amount the copper contents of ore produced by mines having no reduction works and no means of shipment of ore to market.

### EXPENDITURES IN MINING.

| STATES AND TERRITORIES. | Total expenditures. | Total wages. | Salaries. | Paid contractors. | Materials and supplies. | Taxes, rent, etc. | Office force. |
|---|---|---|---|---|---|---|---|
| Total | $12, 062, 180 | $6, 096, 025 | $120, 896 | $334, 443 | $4, 067, 970 | $1, 442, 846 | 70 |
| Michigan | 7, 478, 828 | 3, 174, 303 | 67, 369 | 306, 627 | 2, 682, 491 | 1, 247, 978 | 41 |
| Montana | 3, 204, 455 | 2, 010, 940 | 22, 515 | 2, 722 | 1, 029, 990 | 138, 288 | 10 |
| Arizona | 1, 146, 819 | 726, 021 | 23, 762 | 23, 774 | 325, 020 | 48, 242 | 14 |
| New Mexico | 232, 078 | 184, 701 | 7, 250 | 1, 320 | 30, 469 | 8, 338 | 5 |

## NUMBER OF EMPLOYÉS.

### ABOVE GROUND.

| STATES AND TERRITORIES. | NUMBER EMPLOYED. | | | | AVERAGE DAILY WAGES. | | | | AVERAGE NUMBER OF DAYS EMPLOYED. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Foremen. | Mechanics. | Laborers. | Boys. | Foremen. | Mechanics. | Laborers. | Boys. | Foremen. | Mechanics. | Laborers. | Boys. |
| Total | 84 | 741 | 1,718 | 20 | $5.28 | $2.88 | $1.91 | $0.88 | 305 | 304 | 297 | 304 |
| Michigan | 63 | 547 | 1,247 | 15 | 5.31 | 2.30 | 1.58 | 0.75 | 313 | 311 | 301 | 303 |
| Montana | 7 | 131 | 162 | ....... | 4.86 | 4.76 | 3.13 | ......... | 289 | 300 | 274 | ........ |
| Arizona | 11 | 57 | 252 | 5 | 5.43 | 3.97 | 2.63 | 1.25 | 276 | 260 | 286 | 3 5 |
| New Mexico | 3 | 6 | 57 | ....... | 5.00 | 3.75 | 2.50 | ......... | 269 | 221 | 314 | ....... |

### BELOW GROUND.

| STATES AND TERRITORIES. | Foremen. | Mechanics. | Laborers. | Boys. | Foremen. | Mechanics. | Laborers. | Boys. | Foremen. | Mechanics. | Laborers. | Boys. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 114 | 4,236 | 1,725 | 83 | 4.43 | 2.71 | 1.74 | 0 95 | 299 | 298 | 306 | 3 8 |
| Michigan | 57 | 2,101 | 1,582 | 83 | 4.04 | 1.99 | 1.67 | 0.95 | 312 | 314 | 307 | 308 |
| Montana | 30 | 1,609 | [illegible] | ....... | 4.93 | 3.53 | 3.00 | ......... | 300 | 281 | 129 | ........ |
| Arizona | 23 | 408 | 82 | ....... | 4.89 | 3.19 | 2.62 | ......... | 274 | 290 | 308 | ........ |
| New Mexico | 4 | 118 | 52 | ....... | 3.71 | 2.58 | 2.25 | ......... | 259 | 274 | 293 | ........ |

## CAPITAL INVESTED.

| STATES AND TERRITORIES. | Total. | Land. | Buildings. | Tools. | Cash. |
|---|---|---|---|---|---|
| Total | $62,623,228 | $50,113,325 | $5,817,680 | $3,386,588 | $3,305,635 |
| Michigan | 33,111,253 | 22,333,442 | 5,449,271 | 2,272,622 | 3,055,918 |
| Montana | 23,395,000 | 22,375,000 | 223,000 | 797,000 | ............ |
| Arizona | 5,490,050 | 4,960,383 | 33,409 | 247,791 | 248 467 |
| New Mexico | 626,925 | 444,500 | 112,000 | 69,175 | 1,250 |

## POWER USED.

| STATES AND TERRITORIES. | Animals. | Boilers. | Horse power. | Engines. |
|---|---|---|---|---|
| Total | 305 | 226 | 34,390 | 265 |
| Michigan | 191 | 141 | 29,545 | 151 |
| Montana | 29 | 52 | 3,530 | 82 |
| Arizona | 66 | 21 | 775 | 25 |
| New Mexico | 19 | 12 | 540 | 7 |

## LAKE SUPERIOR DISTRICT.

From an industrial point of view the conditions under which the Lake Superior copper-mining companies work are unique. The occurrence of the metal in the native state created problems for the solution of which experience in older mining regions could furnish no guide. Untrammeled by conventional methods, they have been attacked in a characteristically American manner. After an experience extending over a generation it may well be claimed that the practice of the majority of the mines is entitled to the claim of ranking with the best in this country. By systematic mining, by the liberal introduction of power drills, by the cheap handling of large quantities of rock, and by the development of crushing apparatus of great power well adapted to the special requirements it has become possible in the Lake Superior district to profitably extract copper from very low-grade rock.

While the district possesses certain great advantages, it is unquestionably hampered by drawbacks. The metal exists in the rock in the native state. The ore needs only to be crushed and washed to leave behind a product called "mineral", consisting of metallic copper. From the fact that the product of 117,804,926 pounds of mineral yielded 87,455,675 pounds of ingot it follows that the average percentage of copper is 74.24; but, on the other hand, the amount of native copper in the rock is small in the majority of cases. The total amount of ore hoisted to the surface, not including the few small mines worked by tributers and one of the larger mines, was 2,363,733 short tons. This yielded 86,604,283 pounds of ingot. The average yield of the principal mines was only 1.83 per cent of ingot. Excluding, however, the 2 phenomenally rich mines, the Calumet and Hecla and the Tamarack, the others produced from 1,369,180 tons of rock 27,330,536 pounds of ingot, so that the yield was 0.998, or almost 1 per cent of ingot copper. It follows, therefore, that a large tonnage must be hoisted to produce a moderate amount of copper. This, in turn, means very extensive underground development and a large investment in plant and machinery for power drills, hoisting, crushing, and washing. Since the latter requires a large quantity of water, stamp mills have been located where it is most readily available and where the enormous quantity of sand can be readily disposed of. The result is that the transportation of the rock from the mine to the mill becomes an additional problem.

These conditions impose upon the Lake Superior copper companies a conservative policy, and rob them to some extent of the ability to quickly adapt themselves to rapid fluctuations in the demand and supply. They can not at short notice respond to calls for increased product, because preparations for an extension of operations involve the expenditure of large sums, extended underground development, and large additions to plant and equipment, with the long time which the execution of such plans requires. They are similarly hampered in any plans for an adjustment to the conditions which an overstocked market imposes. Low costs are based, in operations involving the handling of large quantities of rock, upon the full employment of equipment and force. Any curtailment means an undue burden of operating expenses and fixed charges upon a diminished product, while total suspension of operations presents the alternative of either providing for a steady outlay for the maintenance of mine and plant or ultimately, upon resumption, of paying a far larger aggregate sum as a penalty for neglect. It is natural, therefore, that, consciously or not, the managers of the Lake Superior copper companies have usually followed a conservative course.

Another result, which is the outgrowth of the conditions under which the mines must be worked, is the full employment given to labor in the district. This is well illustrated in the figures for labor and wages. With the exception of 1 mine, which was closed down for 50 days on account of the low price of copper, every company ranking as a regular producer has given full employment all the year round, Sundays and legal holidays being the only days of rest, to which must be added the respective holidays of the different nationalities represented. The total wages paid in the mining of copper rock at Lake Superior below and above ground were $3,174,363, including the estimated earnings of tributers at 4 mines, which have been placed at less than $8,000. 2 mines were developed during the census year. The companies which hoisted 2,363,733 tons of rock and produced 86,604,283 pounds of ingot paid in wages $3,004,621, so that the labor cost per ton of rock hoisted was $1.27, while it amounted to 3.47 cents per pound of ingot. It was the lowest in the case of the Atlantic mine, whose labor cost was only 67 cents per ton of rock hoisted. It should be noted that probably an even better expression of the labor cost of mining would be furnished by taking as the basis the tonnage of rock mined, some of the companies rejecting a varying quantity of rock underground. The total cost of mining rock which finally yielded 87,455,675 pounds of ingot copper was as follows:

COST OF MINING COPPER-BEARING ROCK IN THE LAKE SUPERIOR DISTRICT.

| | |
|---|---|
| Wages | $3, 174, 363 |
| Salaries | 67, 369 |
| Paid contractors | 306, 627 |
| Materials and supplies | 2, 682, 491 |
| Taxes, rent, and other outlays | 1, 247, 978 |
| Total | 7, 478, 828 |

### STAMP MILLS.

Reports from 11 stamp mills connected with or working for mines which hoisted 2,363,733 tons of rock show that 2,137,653 tons were crushed, producing mineral yielding 86,604,283 pounds of ingot copper. The difference in the tonnage treated is due principally to the fact that many companies find it necessary to reject in the rock houses a part of the material hoisted as too poor to go to the stamp mill. To some extent also a difference in the quantity of rock in stock at the stamp mill of at least 1 company in the beginning and at the end of the year accounts for the difference.

Like the mines, the stamp mills are operated during the entire year, with stoppages only during Sundays and holidays, so that the men are fully employed. The total wages paid in stamp mills were $514,756.79, so that the labor cost of stamping and washing per ton of rock hoisted averaged 21.8 cents, and per ton crushed 24.08 cents, while it amounted to 0.59 cent per pound of ingot. The number of men employed, their average wages, the maximum and minimum, and the average number of days worked are given in the following table:

EMPLOYÉS AT LAKE SUPERIOR COPPER STAMP MILLS.

| CLASSES. | Number. | Average daily wages. | Maximum | Minimum. | Average number of days employed. |
|---|---|---|---|---|---|
| Foremen | 19 | $3.68 | $4.85 | $2.83 | .......... |
| Mechanics | 128 | 2.17 | 2.75 | 1.80 | 317 |
| Laborers | 795 | 1.52 | 1.75 | 1.12 | 307 |
| Boys | 87 | 0.91 | 1.10 | 0.61 | 307 |

The stamp mills report expenditures for supplies of $570,724.33 (it should be noted, however, that in several instances no accurate separation between mine and mill supplies could be made); expenditures for salaries were $2,340; there was paid to contractors $2,618.71, and for insurance, rent, etc., $2,935.99, while the proportion of the taxes, rent, and other outlays to be credited to the stamp mills is estimated at $406,976.08, a total of $985,595.11. The outlays for salaries, taxes, insurance, etc., are, however, credited in total to the mining account, a separation being possible only in a very few instances.

## MONTANA.

The product of those mines in Montana which may be classed as copper mines was 97,868,064 pounds of fine copper produced from 698,837 tons of rock, thus showing that the yield was 7 per cent.

The total expenditures involved in mining were as follows:

### EXPENDITURES IN COPPER MINING IN MONTANA.

| | |
|---|---|
| Wages | $2,010,940 |
| Salaries | 22,515 |
| Paid contractors | 2,722 |
| Materials and supplies | 1,029,990 |
| Taxes, rents, and other outlays | 138,288 |
| Total | 3,204,455 |

Concerning the smelting and concentrating operations the following data may be presented. It will be observed that the cost of operating this plant is nearly double that of the mining operations proper.

### RESULTS OF SMELTING AND CONCENTRATING MONTANA COPPER ORES.

| | POUNDS. |
|---|---|
| Matte | 156,400,590 |
| Blister | 10,176,744 |
| Fine copper contents, copper | 102,188,716 |

### LABOR AND WAGES.

| CLASSES. | Number. | Average daily wages. | Average number of days employed. |
|---|---|---|---|
| Foremen | 90 | $5.00 | 355 |
| Mechanics | 139 | 4.08 | 351 |
| Laborers | 1,789 | 2.91 | 324 |
| Boys | 20 | 1.75 | 365 |

### EXPENDITURES.

| | |
|---|---|
| Total wages paid | $2,128,569.89 |
| Salaries (24 persons) | 50,493.75 |
| Paid contractors | 30,106.45 |
| Supplies and materials | 3,901,551.05 |
| Rent, interest, insurance, taxes, etc | 186,817.45 |
| Total | 6,297,538.59 |

It will be observed from the statement of wages paid that, generally speaking, they are nearly double those paid in the Lake Superior district, but that per ton of product they are considerably less, owing to the higher grade of the ore mined. With the exception, however, of the bessemerized copper produced by the Parrot company, the product must be first concentrated and subsequently smelted for matte, which is sold to American and foreign refiners.

A part of the product of one establishment was sold to another in the same district. The capital investment of all the mines is not reported, but it may be stated that the works produced in all 108,261,092 pounds of matte, containing 66,130,647 pounds of fine copper, and had invested in buildings and fixtures $2,195,000, in tools, implements, and machinery, $5,425,700, and in cash, $240,000. The number of animals employed was 29, and the plant included 52 boilers, of 3,530 horse power, 5 steam stamps with 250 horse power, and 82 engines.

The product of the concentrating and smelting operations is matte. The cost of transportation to market and the cost for refining must be added. Some of the companies, however, as an offset, draw a considerable revenue from the silver contents of the matte produced. This must be taken into account when dealing with the ability of the mines to compete in the world's markets.

## ARIZONA.

The principal advantage of the Arizona mines as competitors in the copper market lies in the fact that the ores are relatively rich, yielding in 1889 a fraction over 10 per cent, and are easily reduced to black copper, being almost exclusively oxidized ores. The expenditures incurred in producing ore which yielded 31,362,685 pounds of fine copper were as follows:

### EXPENDITURES AT COPPER MINES.

| | |
|---|---|
| Wages | $726, 021 |
| Office force (14 persons) | 23, 762 |
| Paid contractors | 23, 774 |
| Supplies and materials | 325, 020 |
| Taxes, rent, etc | 48, 242 |
| Total | 1, 146, 819 |

The smelting and concentrating of the ores involved the following expenditures and employed the following force:

### LABOR AND WAGES AT COPPER-SMELTING WORKS.

| CLASSES. | Number. | Average daily wages. | Average number of days employed. |
|---|---|---|---|
| Foremen | 14 | $5. 34 | 281 |
| Mechanics | 21 | 4. 13 | 274 |
| Laborers | 370 | 2. 87 | 306 |

### EXPENDITURES.

| | |
|---|---|
| Wages | $345, 787. 11 |
| Office force (10 persons) | 22, 998. 00 |
| Paid contractors | 26, 686. 65 |
| Supplies and materials | 816, 243. 70 |
| Rent, interest, taxes, etc | 46, 177. 41 |
| Total | 1, 257, 892. 87 |

### POWER.

| | |
|---|---|
| Animals employed | 5 |
| Steam boilers: | |
| Number | 9 |
| Horse power | 790 |
| Steam engines | 8 |

### CAPITAL.

| | |
|---|---|
| Buildings and fixtures | $176, 016 |
| Tools, implements, and machinery | 280, 200 |
| Cash | 7, 000 |
| Total | 463, 216 |

## STATISTICS OF COPPER REFINING IN THE UNITED STATES.

Only a part of the furnace material produced in the United States, a small quantity of ore, and nearly all of the mineral from the Lake stamp mills are refined in works the majority of which are controlled by firms and corporations not directly connected with the mines. In some works copper refining is incidental to the working of other base and precious metals, and in others it is a part of a general chemical business. One concern has failed to report. Returns cover establishments which produced 159,693,252 pounds of refined copper, valued at $19,686,561.86. The following are the data relating to them:

### CAPITAL.

| | |
|---|---|
| Lands | $634, 000 |
| Buildings and fixtures | 1, 758, 856 |
| Tools, implements, etc | 600, 214 |
| Cash, etc | 1, 044, 523 |
| Total | 4, 037, 593 |

### LABOR AND WAGES.

| CLASSES. | Number. | Average daily wages. | Average number of days employed. |
|---|---|---|---|
| Foremen | 70 | $3.59 | 314 |
| Mechanics | 334 | 2.68 | 307 |
| Laborers | 915 | 1.57 | 304 |
| Boys | 9 | 0.78 | 313 |

### EXPENDITURES.

| | |
|---|---|
| Wages | $800,484 |
| Salaries (43 persons) | 71,720 |
| Paid contractors | 19,591 |
| Supplies and materials | 737,098 |
| Rent, interest, insurance, taxes, etc | 256,368 |
| Total | 1,885,261 |

### POWER.

| | |
|---|---|
| Animals | 37 |
| Steam boilers: | |
| Number | 28 |
| Horse power | 2,152 |
| Steam engines | 30 |

It is interesting to segregate 1 group of refiners, which treats exclusively high-grade, pure material, like Lake mineral, Arizona bars, and Montana blister copper. Works which produced 105,400,664 pounds of refined copper incurred the following total expenses:

### EXPENSES IN COPPER WORKS TREATING HIGH-GRADE MATERIAL.

| | |
|---|---|
| Wages | $326,687 |
| Salaries | 42,056 |
| Paid to contractors | 4,735 |
| Supplies and materials | 305,679 |
| Rent, interest, etc | 40,462 |
| Total | 719,619 |
| or 0.68 cent per pound. | |
| Total refined copper, pounds | 105,400,664 |

# LEAD AND ZINC.

# LEAD AND ZINC.

BY CHARLES KIRCHHOFF.

Although one of the great industries, lead mining is carried on in only a few localities for the production of lead ore pure and simple. It is the usual practice to separate the product of mines into 2 groups, that in which the baser metal is associated with the precious metals, and that in which it is practically free from gold and silver. The first group includes all the mines producing lead-bearing ores in the Rocky mountains.

## LEAD PRODUCT OF THE ROCKY MOUNTAIN REGION.

All the ores of this great division carry gold and silver associated with the base metal. If the principle be adopted of classifying an ore in accordance with its constituent of chief value, a few mines in the Rocky mountains might be classed as lead mines. In order to avoid the confusion, perplexity, and annoyance which would grow out of duplicate correspondence, the investigation so far as lead in the Rocky mountain region is concerned was confined to gathering data as to the lead contents of ores and their value.

Since the concentration of lead-smelting operations in certain localities and the shipment of ore for treatment from one state or territory to another, the task of tracing to its source the lead contents of ores in the Rocky mountain region has outgrown the resources of ordinary statistical research. Those familiar with the difficulties of territorially distributing the lead product of the Rocky mountain region have long since recognized that the only means of arriving at accurate results is to take a census of the mines themselves. It is to this that the present investigation has been confined, and the following summary presents the result:

SUMMARY OF LEAD PRODUCTION IN THE ROCKY MOUNTAIN STATES AND TERRITORIES.

| STATES AND TERRITORIES. | Tons. | Value. | STATES AND TERRITORIES. | Tons. | Value. |
|---|---|---|---|---|---|
| Total | 130, 903 | $4, 712, 757. 27 | Montana | 10, 183 | $456, 975. 40 |
| | | | Nevada | 1, 994 | 72, 653. 64 |
| Arizona | 3, 158 | 98, 747. 84 | New Mexico | 4, 764 | 170, 754. 59 |
| California | 53 | 1, 999. 65 | South Dakota | 116 | 4, 653. 44 |
| Colorado | 70, 788 | 2, 101, 014. 31 | Utah | 16, 675 | 763, 329. 09 |
| Idaho | 23, 172 | 1, 042, 629. 31 | | | |

LEAD PRODUCTION IN THE ROCKY MOUNTAIN STATES AND TERRITORIES, BY COUNTIES.

ARIZONA.

| COUNTIES. | Pounds. | Value. |
|---|---|---|
| Cochise | 2, 548, 884 | $25, 223. 77 |
| Gila | 570 | 9. 97 |
| Mohave | 618, 644 | 10, 444. 65 |
| Pima | 2, 303, 929 | 48, 684. 73 |
| Yavapai | 211, 090 | 3, 302. 72 |
| Yuma | 633, 257 | 11, 082. 00 |
| Total | 6, 316, 374 | 98, 747. 84 |
| Equals 3,158 tons. | | |

CALIFORNIA.

| COUNTIES. | Pounds. | Value. |
|---|---|---|
| Butte | 400 | 8. 00 |
| Inyo | 94, 110 | 1, 871. 65 |
| San Bernardino | 12, 000 | 120. 00 |
| Total | 106, 510 | 1, 999. 65 |
| Equals 53 tons. | | |

COLORADO.

| COUNTIES | Pounds. | Value. |
|---|---|---|
| Boulder | 18, 050 | $190. 50 |
| Chaffee | 6, 614, 211 | 57, 611. 40 |
| Clear Creek | 3, 078, 247 | 52, 222. 38 |
| Custer | 465, 454 | 11, 617. 81 |
| Dolores | 338, 360 | 6, 973. 00 |
| Eagle | 984, 783 | 10, 060. 94 |
| Fremont | 620, 800 | 6, 208. 00 |
| Gilpin | 2, 026, 819 | 35, 738. 28 |
| Gunnison | 934, 790 | 17, 900. 33 |
| Hinsdale | 516, 620 | 10, 668. 72 |
| Lake | 100, 983, 862 | 1, 448, 643. 65 |
| Ouray | 2, 666, 282 | 39, 129. 88 |
| Park | 556, 880 | 10, 622, 60 |
| Pitkin | 14, 263, 832 | 276, 085. 42 |
| Saguache | 124, 774 | 2, 545. 30 |
| San Juan | 3, 574, 437 | 67, 133. 12 |
| San Miguel | 616, 190 | 10, 037. 00 |
| Summit | 3, 191, 793 | 37, 625. 98 |
| Total | 141, 576, 184 | 2, 101, 014. 31 |
| Equals 70,788 tons. | | |

LEAD PRODUCTION IN THE ROCKY MOUNTAIN STATES AND TERRITORIES, BY COUNTIES—Continued.

IDAHO.

| COUNTIES. | Pounds. | Value. |
|---|---|---|
| Alturas | 2,438,425 | $64,438.79 |
| Custer | 1,275,193 | 21,215.45 |
| Logan | 5,501,370 | 115,040.23 |
| Shoshone | 37,128,890 | 841,934.84 |
| Total | 46,343,878 | 1,042,629.31 |
| Equals 23,172 tons. | | |

MONTANA.

| COUNTIES. | Pounds. | Value. |
|---|---|---|
| Beaverhead | 6,906,258 | 169,008.45 |
| Deerlodge | 640,000 | 13,398.75 |
| Fergus | 39,200 | 793.80 |
| Jefferson | 10,161,004 | 247,696.65 |
| Meagher | 2,119,410 | 15,952.75 |
| Missoula | 500,000 | 10,125.00 |
| Total | 20,365,872 | 456,975.40 |
| Equals 10,183 ton | | |

NEVADA.

| COUNTIES. | Pounds. | Value. |
|---|---|---|
| Elko | 60,000 | 980.00 |
| Eureka | 2,977,040 | 56,065.07 |
| Lincoln | 659,516 | 10,751.09 |
| Nye | 19,674 | 233.70 |
| White Pine | 272,415 | 4,623.78 |
| Total | 3,988,645 | 72,653.64 |
| Equals 1,994 tons. | | |

NEW MEXICO.

| COUNTIES. | Pounds. | Value. |
|---|---|---|
| Donna Ana | 2,057,100 | $35,916.50 |
| Grant | 3,235,310 | 44,623.06 |
| Lincoln | 60,000 | 600.00 |
| Santa Fe | 1,101,000 | 22,020.00 |
| Sierra | 678,853 | 9,536.06 |
| Socorro | 2,374,759 | 57,858.97 |
| Taos | 20,000 | 200.00 |
| Total | 9,527,022 | 170,754.59 |
| Equals 4,764 tons. | | |

SOUTH DAKOTA.

| COUNTIES. | Pounds. | Value. |
|---|---|---|
| Lawrence | 232,672 | 4,653.44 |
| Equals 116 tons. | | |

UTAH.

| COUNTIES. | Pounds. | Value. |
|---|---|---|
| Beaver | 8,974,084 | 179,293.08 |
| Juab | 260,141 | 4,765.38 |
| Piute | 140,375 | 2,885.62 |
| Salt Lake | 9,588,325 | 205,336.85 |
| Summit | 11,362,293 | 306,455.59 |
| Tooele | 2,965,171 | 64,442.57 |
| Wasatch | 60,000 | 150.00 |
| Total | 33,350,389 | 763,329.09 |
| Equals 16,675 tons. | | |

Since, with very few exceptions, the mines producing ore carrying lead yield the precious metals in greater value, the data relating to labor, wages, and capital are comprised in the totals collected on the mining of gold and silver.

## LEAD ORES OF THE MISSISSIPPI VALLEY.

While the lead-bearing ores of the Rocky mountain region are almost universally purchased by sampling works or refiners according to assay, so that their lead contents are easily reported, the product of the second group, the nonargentiferous lead mines of Kansas, Missouri, and Wisconsin, is bought without an exact determination of its lead contents. The reports of the smelters in those districts, however, indicate their grade quite clearly.

The prevalence of the leasing system placed great obstacles in the way of the work of collecting reliable statistics in Kansas, Missouri, and Wisconsin. The owners of the land lease the mining right to others for a royalty, and the lessees in many cases again sublet portions of the ground to individuals or groups of miners. In numerous instances the actual operators work only for short periods or erratically, and no records are kept of the number of employés, their outlays, or their earnings. So far as it was possible visits were made to the groups of miners, so as to arrive at some data concerning the number of persons employed, the length of time of their employment, and their earnings. Valuable data have thus been collected, notably for the Shullsburg district, in Wisconsin, where this system of collecting the statistics was most thoroughly carried out by Mr. James Freeman, of Shullsburg, involving, as it did, repeated personal interviews with the small groups of men acting in partnership. In other parts of the district, particularly at some of the isolated points, digging for zinc and lead ore is pursued in the intervals of slack work on the farms. It was not considered advisable to carry out the plan of strictly separating labor into two groups, above and below ground, because the work, even where underground mining is necessary, is not assigned strictly to different groups of men. In the smaller operations from 2 to 5 or more individuals work in partnership, sharing alike. In these cases the force has been grouped with the miners and operators. In more ambitious undertakings one or more laborers are hired by the partners at a fixed rate of wages, and have been grouped as such. The earnings of the partners have been regarded as equivalent to wages, and have been arrived at by deducting from the gross receipts for ore sold, first, the royalty paid, then the amounts expended for supplies and hauling ore, and, finally, the sums paid to hired labor. The balance has been computed as per diem wages on the basis of the reports made. In a few isolated cases the men have either lost money or have earned a very meager return for their labor. The earnings appear to rise very rarely above the returns obtained by skilled labor. Thus the reports show that they approached $5 per day exceptionally for moderate periods of time, while they were below $1 in a surprisingly large number of instances. In the aggregate the total product of the mines thus worked by lessees, for example, in Wisconsin, is quite large, although the output of the few companies and firms regularly employing large bodies of men constitute a very heavy percentage of the total.

### WISCONSIN.

As typical of the system, the following detailed tables are presented relating to Wisconsin. The mining industry in this state more closely approaches that of the primitive conditions than it does in any other part of this country. The amount of machinery employed, excepting by 1 large company, is small, and the quantity of supplies consumed is very low, even if due allowance be made for the probability that small operators did not fully report their outlays in this respect. The character of the deposits has not, apparently, lent itself readily to systematic operations on a large scale, so that the greater part of the product is the direct result of manual labor applied to small individual operations. Since they are largely surface diggings, the period of employment is short, and, considering all the circumstances, the earnings are very moderate. The individual returns indicate clearly that the element of chance enters more frequently into mining so far as the yield of lead ore is concerned. Occasionally there are large findings of this ore, which apparently contribute more frequently to exceptional earnings, although at the best they rarely exceed the rate of wages paid to skilled labor in some sections of the country. The table shows clearly that the average earnings of lessees are not much greater than those of day laborers.

In Wisconsin the number of mines producing lead ore exclusively is small, and both in tonnage and in value lead is the by-product, the main reliance being the zinc ore.

#### LEAD AND ZINC ORE PRODUCED IN WISCONSIN.

| COUNTIES. | Total value. | Zinc ore produced. (Pounds.) | Value. | Lead ore produced. (Pounds.) | Value. |
|---|---|---|---|---|---|
| Total | $464, 630. 39 | 49, 663, 765 | $400, 567. 86 | 3, 355, 159 | $64, 062. 53 |
| Iowa | 249, 864. 53 | 33, 992, 803 | 237, 462. 98 | 811, 035 | 12, 401. 55 |
| Lafayette | 180, 833. 68 | 14, 264, 262 | 152, 972. 88 | 1, 457, 424 | 27, 860. 80 |
| Grant | 31, 172. 18 | 1, 406, 700 | 10, 132. 00 | 966, 700 | 21, 040. 18 |
| Green | 2, 760. 00 | ........ | ........ | 120, 000 | 2, 760. 00 |

#### LABOR EMPLOYED IN LEAD AND ZINC MINING IN WISCONSIN.

| COUNTIES. | Number of foremen. | Number of mechanics. | Number of miners or operators. | Number of laborers. | Number of boys. |
|---|---|---|---|---|---|
| Total | 25 | 24 | 598 | 488 | 10 |
| Iowa | 16 | 5 | 380 | 224 | ........ |
| Lafayette | 8 | 18 | 167 | 235 | 10 |
| Grant | 1 | 1 | 49 | 27 | ........ |
| Green | ........ | ........ | 2 | 2 | ........ |

#### EXPENSES OF LEAD AND ZINC MINING IN WISCONSIN.

| COUNTIES. | Total expenses. | Total wages paid and net earnings of individual operators. | Amount paid to contractors. | Royalty paid on zinc ore. | Royalty paid on lead ore. |
|---|---|---|---|---|---|
| Total | $383, 438. 72 | $308, 506. 37 | $25, 286. 36 | $43, 175. 73 | $6, 470. 26 |
| Iowa | 209, 908. 74 | 166, 132. 52 | 19, 788. 20 | 22, 748. 55 | 1, 239. 47 |
| Lafayette | 147, 054. 67 | 120, 776. 61 | 4, 623. 66 | 19, 575. 59 | 2, 078. 81 |
| Grant | 23, 715. 31 | 19, 302. 24 | 754. 50 | 851. 59 | 2, 806. 98 |
| Green | 2, 760. 00 | 2, 295. 00 | 120. 00 | ........ | 345. 00 |

The averages of wages paid per day as given in the following and all similar tables were obtained from statements of operators, and are independent of the gross amount paid in wages:

### LENGTH OF EMPLOYMENT AND EARNINGS OF LABOR IN LEAD AND ZINC MINING IN WISCONSIN.

| COUNTIES. | TOTAL. | | FOREMEN. | | MECHANICS. | | MINERS OR OPERATORS. | | LABORERS. | | BOYS. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average daily wages. | Average days employed. | Average daily wages. | Average days employed. | Average daily wages. | Average days employed. | Average daily wages. | Average days employed. | Average daily wages. | Average days employed. | Average daily wages. | Average days employed. |
| Iowa | $1.99 | 200 | $1.60 | 166 | $2.18 | 185 | $1.27 | 191 | $1.30 | 215 | | |
| Lafayette | 2.53 | 262 | 2.18 | 185 | 1.96 | 286 | 1.45 | 136 | 1.26 | 246 | $0.85 | 193 |
| Grant | 2.00 | 52 | 2.00 | 52 | 2.00 | 52 | 1.79 | 121 | 1.25 | 197 | | |
| Green | | | | | | | 2.57 | 300 | 1.25 | 300 | | |

### SOUTHWEST MISSOURI.

The difficulty of collecting data for the lead and zinc mining industry in southwest Missouri was insuperable. The fact is that no records exist except with the larger companies, and they deal simply with product in the majority of cases. Even the statement of output was found to vary when made at various times by different officials. Those from whom the companies leased the land could furnish no information whatever as to the number of men employed, the length of their employment, or their necessary outlays and earnings. An attempt was made to reach the groups of miners acting as lessees of small tracts, but it was found that the life of many such partnerships was so short that those which had been in existence early in the census year had long dissolved, and that the majority of those reached possessed no records whatever.

The situation in the district is best characterized by the following abstract from a letter of the best-informed engineer of that section, a man of broad views and familiar with conditions in other sections of the country:

> The mining contracts which the owners of the land enter into are often erroneously spoken of as leases. There are, however, important points involved in the distinction, some landholders being careful to retain possession of the ownership of the ore and all mining rights. The landowner in many cases receives the money from the sale of all ores and pays every week to some authorized agent of the registered holders of lots, whose ores have been sold, the contract price for mining the ore and preparing it for market. That price is $25 per 1,000 pounds when pig lead is quoted at 7 cents in the Saint Louis market, and a proportionate sum as the price varies from 7 cents, and a proportionate price for inferior mineral. $2 per 1,000 pounds of lead ore are deducted and $1 per ton on zinc ore is deducted for pump rent. The price paid for zinc ore cleaned ready for market varies between 77.5 and 80 per cent of the value of the zinc contained. In the great majority of lots, which rise in number to upward of 200 for 1 company, the ore is taken out and cleaned by subcontractors. Settlements are made every week in cash, and the mining company has no means of knowing how the money which it pays out is divided. It is a question whether books are kept for a single one out of hundreds of lots which would give the figures called for in the census schedules.

These indications permit of an estimate of the total wage fund distributed.

In Missouri the product of the mines has been as follows:

### PRODUCT OF LEAD AND ZINC ORES IN MISSOURI.

| COUNTIES. | ZINC ORE. | | LEAD ORE. | |
|---|---|---|---|---|
| | Pounds. | Value. | Pounds. | Value. |
| Total | 186,262,308 | $2,024,057.14 | 88,964,146 | $1,571,161.04 |
| Barry | 360,000 | 2,340.00 | | |
| Dade | 306,000 | 1,308.00 | 152,000 | 3,240.00 |
| Greene | 1,352,430 | 17,139.00 | 660,630 | 9,371.50 |
| Jasper | 144,051,380 | 1,629,537.59 | 11,619,430 | 245,856.52 |
| Lawrence | 18,926,354 | 158,665.27 | 6,009,871 | 118,161.28 |
| Madison | | | 11,000,197 | 145,589.81 |
| Morgan | 31,000 | 480.00 | | |
| Newton | 16,615,144 | 191,487.28 | 339,557 | 7,074.00 |
| Saint François | 4,620,000 | 23,100.00 | 57,027,745 | 1,014,162.13 |
| Washington | | | 2,148,716 | 27,705.80 |

It will be observed that in Greene, Jasper, Lawrence, Newton, and Saint François counties the mines produce heavily both of zinc and lead ore. In the majority of instances both ores are mined from the same openings, the zinc preponderating, however, both in quantity and value. The same is true of the adjoining mining district of Cherokee county, Kansas. The smaller number of producers and the concentration of the business in the hands of larger concerns have made it possible to present more elaborate data on the industry. In the zinc ore product is included a considerable quantity of rough ore, the mining companies in some cases being unable to report the exact equivalent in clean, merchantable ore. This accounts for the apparent excess of ore mined over the quantity used at the zinc smelters.

STATISTICS OF ZINC AND LEAD MINES IN KANSAS.

| | | |
|---|---|---|
| Zinc ore produced, pounds | 79, 150, 902 | |
| Value of zinc ore | | $299, 192. 05 |
| Lead ore produced, pounds | 7, 233, 778 | |
| Value of lead ore | | 108, 236. 42 |
| Total value | | 407, 428. 47 |
| Wages paid | | 293, 197. 20 |
| Salaries | | 9, 166. 00 |
| Contractors | | 700. 00 |
| Supplies and materials | | 53, 520. 02 |
| Insurance, taxes, rent, etc | | 7, 135. 73 |
| Total expenditures | | 363, 718. 95 |

### MISSOURI LEAD MINES.

In order to arrive at some data which might throw light on the condition of the lead-mining industry of Missouri proper, the figures were aggregated which deal with mines in that state producing lead ore exclusively. Although there are a few diggings in the mineral belt characteristic of producing the two ores together which happened to yield only lead ore in the census year, they were omitted from the aggregate, which includes the 2 great mines of Saint François county, the Saint Joe and the Doe Run, the Mine La Motte, and the mines of Washington county. Of the 88,964,146 pounds of lead ore produced in the state of Missouri 69,532,873 pounds were from mines producing this mineral alone.

The following table shows the number of persons employed above and below ground, with the average wages per day and the average number of days worked:

STATISTICS OF MISSOURI LEAD MINES.

| EMPLOYÉS. | Number employed. | Average daily wages. | Average days employed. |
|---|---|---|---|
| Total | 1, 118 | $1. 25 | 274 |
| ABOVE GROUND. | | | |
| Foremen | 21 | 2. 19 | 332 |
| Mechanics | 106 | 1. 63 | 302 |
| Laborers | 306 | 1. 27 | 308 |
| Boys | 8 | 0. 72 | 309 |
| BELOW GROUND. | | | |
| Foremen | 22 | 1. 87 | 306 |
| Miners | 411 | 1. 13 | 218 |
| Laborers | 244 | 1. 12 | 305 |

EXPENDITURES.

| | |
|---|---|
| Wages | $401, 430. 77 |
| Paid contractors | 8, 525. 05 |
| Supplies, etc | 244, 783. 84 |
| Rent, taxes, etc | 142, 153. 55 |
| Total | 796, 893. 21 |

It must be noted that the average wages of the miners are lowered because of the low wages paid in the Washington county mines, where $1 per day is the general rate, and as low as 70 cents per day is paid for what is not skilled miners' labor.

## EASTERN AND SOUTHERN ZINC MINES.

In the east the industry differs in character from that of the west, since there is only one mining operation in Virginia in which the ores of both metals are extracted from the same deposits. The number of operators is small, and it has been deemed expedient, therefore, to place the mines in 2 natural groups, one embracing New Jersey and Pennsylvania and the other, the southern group, including Virginia and Tennessee.

STATISTICS OF EASTERN AND SOUTHERN ZINC MINES.

| STOCK, CAPITAL, LABOR, ETC. | Eastern. | Southern. |
|---|---|---|
| Zinc ore produced, tons | 63, 339 | 12, 906 |
| Value of product | $175, 052 | $141, 560 |
| STOCK OF ORE: | | |
| January 1, 1889, short tons | 21, 363 | 3, 100 |
| January 1, 1890, short tons | 26, 724 | 1, 478 |
| CAPITAL: | | |
| Land | $612, 500 | $194, 000 |
| Buildings and fixtures | 25, 510 | 32, 000 |
| Tools, implements, and machinery | 152, 093 | 32, 000 |
| Cash, etc | ........ | 1, 000 |
| Total | 790, 103 | 259, 000 |
| LABOR: | | |
| Number employed above ground— | | |
| Foremen | 4 | 28 |
| Mechanics | 24 | 19 |
| Laborers | 65 | 586 |
| Boys | 8 | 45 |
| Number employed below ground— | | |
| Foremen | 8 | 1 |
| Miners | 54 | 59 |
| Laborers | 62 | 2 |
| Boys | 2 | 1 |
| Office force— | | |
| Males | 6 | 8 |
| Total employés | 233 | 749 |
| Average daily wages above ground— | | |
| Foremen | $4. 02 | $1. 76 |
| Mechanics | 1. 68 | 1. 33 |
| Laborers | 1. 15 | 0. 99 |
| Boys | 0. 59 | 0. 50 |
| LABOR—continued. | | |
| Average daily wages below ground— | | |
| Foremen | $2. 41 | $3. 00 |
| Miners | 1. 49 | 1. 07 |
| Laborers | 1. 26 | 0. 75 |
| Boys | 0. 72 | 0. 30 |
| Average length of employment above ground, in days— | | |
| Foremen | 307 | 314 |
| Mechanics | 310 | 273 |
| Laborers | 302 | 171 |
| Boys | 312 | 202 |
| Average length of employment below ground, in days— | | |
| Foremen | 310 | 175 |
| Miners | 279 | 171 |
| Laborers | 304 | 150 |
| Boys | 281 | 150 |
| Total wages paid | $84, 683 | $132, 949 |
| OFFICE FORCE: | | |
| Salaries | 5, 617 | 6, 250 |
| Supplies and materials consumed | 53, 039 | 56, 595 |
| Rent, interest, insurance, taxes, etc | 37, 215 | 6, 500 |
| Total expenditures | 180, 554 | 202, 294 |
| POWER: | | |
| Number of steam boilers | 21 | 5 |
| Total horse power | 1, 003 | 130 |
| Number of engines | 12 | 5 |
| Number of animals | 23 | 101 |

It should be noted that one of the southern mines produced also 268 tons of lead ore, valued at $10,720. It will be observed that the working force of the eastern mines is nearly equally distributed between surface and mine labor, while practically all the work done in the southern district is in open cuts, where a large quantity of barren material must be handled.

The total product of the lead and zinc mines of the states east of the Rocky mountains has been as follows:

TOTAL PRODUCT OF THE LEAD AND ZINC MINES EAST OF THE ROCKY MOUNTAINS.

| STATES. | Total value. | ZINC ORE. | | LEAD ORE. | |
|---|---|---|---|---|---|
| | | Short tons. | Value. | Short tons. | Value. |
| Total | $4, 804, 179. 24 | 234, 503 | $3, 049, 799. 25 | 50, 238 | $1, 754, 379. 99 |
| Arkansas | 3, 650. 00 | 130 | 3, 250. 00 | 20 | 400. 00 |
| Illinois | 4, 800. 00 | ........ | ........ | 173 | 4, 800. 00 |
| Iowa | 3, 600. 00 | 450 | 3, 600. 00 | ........ | ........ |
| Kansas | 402, 428. 47 | 39, 575 | 299, 192. 05 | 3, 617 | 103, 236. 42 |
| Missouri | 3, 595, 218. 18 | 93, 131 | 2, 024, 057. 14 | 44, 482 | 1, 571, 161. 04 |
| New Jersey and Pennsylvania | 175, 052. 20 | 63, 339 | 175, 052. 20 | ........ | ........ |
| New Mexico | 2, 520. 00 | 140 | 2, 520. 00 | ........ | ........ |
| Southern states | 152, 280. 00 | 12, 906 | 141, 560. 00 | 268 | 10, 720. 00 |
| Wisconsin | 464, 630. 39 | 24, 832 | 400, 567. 86 | 1, 678 | 64, 062. 53 |

## LEAD SMELTING AND REFINING.

The operations of lead smelting and refining are so inextricably mixed, and are, besides, so often conducted in connection with the parting of the precious metals, that it is quite impossible to present tables covering the operations for the whole country. Nearly all the lead refiners carry on simultaneously a certain amount of ore smelting. They can not segregate the labor and expenditures therefor from those incurred in lead desilverizing, because many intermediate products of the latter are treated together with the ore in the smelting. Others do a large amount of refining and parting of the precious metals, in which the same obstacles are met in keeping accounts. Some couple with their lead business the refining of copper and the manufacture of bluestone. Under these circumstances it is impossible to present data sharply defining the amount of labor employed in the different branches of the industry, or to give accurate statistics concerning the wages paid and the supplies consumed for the whole country. So far as lead smelting is concerned, however, it is possible to segregate certain groups, the statistics of which are largely instructive. First among these is that comprising the works which smelt the product of the nonargentiferous ores of Kansas, Missouri, and Wisconsin. A moderate quantity of this class of ore is purchased by the lead desilverizers, who utilize it to some extent in connection with the treatment of antimonial intermediate products, with the object of obtaining antimonial lead low in silver, which accounts for the difference between the output of the mines and the quantity worked by the smelters. The following table summarizes the data relating to this group:

### STATISTICS OF SMELTERS OF NONARGENTIFEROUS LEAD ORES IN ILLINOIS, KANSAS, MISSOURI, AND WISCONSIN.

| | |
|---|---|
| Product of refined lead, short tons | 29, 258 |
| Product of sublimed lead, short tons | 1, 250 |
| Stock, January 1, 1889, short tons | 4, 058 |
| Stock, January 1, 1890, short tons | 5, 367 |
| Quantity of ore treated, short tons | 49, 816 |
| Value of ore treated | $1, 664, 020 |

### LABOR EMPLOYED, AVERAGE WAGES PER DAY, AND AVERAGE DAYS EMPLOYED.

| EMPLOYÉS. (a) | Number employed. | Average daily wages. | Average days employed. |
|---|---|---|---|
| Total | 476 | $1. 54 | 293 |
| Foremen | 21 | 2. 31 | 331 |
| Mechanics | 31 | 1. 94 | 273 |
| Laborers | 423 | 1. 47 | 292 |
| Boys | 1 | 0. 50 | 364 |

[a] Office force consists of 15 persons.

### EXPENDITURES.

| | |
|---|---|
| Total wages | $206, 541 |
| Salaries | 19, 680 |
| Paid contractors | 3, 182 |
| Total expenditures for supplies and materials | 184, 175 |
| Rent, taxes, insurance, and all other expenditures | 166, 632 |
| Total | 580, 210 |

That the ore worked is thoroughly dressed by concentration is shown by the fact that the yield averaged 61.24 per cent. Of the total, 21,456 tons is the product of 3 companies, who smelt the ores produced at their own mines. These companies paid in wages and salaries $145,540; for supplies and materials consumed, $144,983, and for rent, taxes, and miscellaneous expenditures for mine and smelting works, $165,164, the ore being valued at $1,179,769. The same concerns incurred an outlay for mine labor of $345,369, and for mine supplies of $233,341, a total direct outlay of $1,034,287. The other smelters in the group under consideration purchase their ore in the open market, quite a number of them operating only on a very small scale, the product being under 300 tons in the majority of cases.

A second group of smelters, the operations of which it is possible to segregate without risk of obscuring the results by the introduction of figures which should be assigned to allied branches of the industry, are the Colorado smelters, the aggregate embracing the reports from 9 plants, the product of base bullion being 67,867 short tons and the quantity of ore treated 602,014 short tons. This group does not include those smelters alone which did a lead-smelting business exclusively.

### STATISTICS OF LEAD SMELTERS IN COLORADO.

| EMPLOYÉS. (a) | Number employed. | Average daily wages. | Average days employed. |
|---|---|---|---|
| Total | 1, 929 | $2. 59 | 317 |
| Foremen | 47 | 4. 17 | 360 |
| Mechanics | 62 | 3. 57 | 345 |
| Laborers | 1, 818 | 2. 52 | 315 |
| Boys | 2 | 0. 75 | 365 |

[a] Office force consists of 77 persons.

### EXPENDITURES.

| | |
|---|---|
| Total wages | $1,645,819.46 |
| Salaries | 206,606.81 |
| Paid contractors | 45,998.03 |
| Value of supplies and materials consumed | 1,774,340.92 |
| Rent, taxes, and miscellaneous expenses | 523,639.88 |
| Total disbursements, exclusive of value of ore | 4,196,405.10 |

For years a sharp competition has been waged between 2 groups of Colorado smelters, those of the Leadville and the Valley districts. The following table gives aggregates covering the operations of all the former and those of the latter which do exclusively a smelting business:

### DETAILED STATISTICS OF COLORADO SMELTERS.

| ITEMS. | Leadville. | Valley. |
|---|---|---|
| Product of base bullion, short tons | 26,453 | 40,253 |
| Ore treated, short tons | 238,615 | 350,399 |
| Total wages | $600,447 | $970,373 |
| Salaries | 61,728 | 129,879 |
| Paid contractors | ............ | 30,998 |
| Taxes, rent, and insurance | 269,883 | 233,756 |
| Supplies and materials | 818,402 | 898,949 |
| Total expenditures | 1,750,460 | 2,263,955 |

The most striking fact illustrative of the great progress made in lead smelting is the enormous quantity of ore treated when compared with the relatively small amount of lead produced; in other words, the small quantity of the base metal in the furnace mixture. It proves what progress has been made in smelting where it is possible to add to what may be termed lead ores proper such quantities of strictly argentiferous or dry ores. The average percentage of lead in the mixtures was between 11 and 11.5. The exact amount can not be stated in the absence of any data on the silver contents of the base bullion. A decade since such results would have been unattainable without heavy losses both in the base and precious metals. The figures given illustrate to what extent smelting has become the method of treating silver ores. The cost, too, has been very considerably lowered, having apparently been in the census year $6.97 per ton of material treated, without any allowance, however, for loss of base and precious metals.

The returns from 4 Montana smelters show the product of base bullion to be 16,335 short tons, and the quantity of ore treated 71,403 short tons. The following table shows the number of employés, average wages per day, and average days employed:

### STATISTICS OF MONTANA LEAD SMELTERS.

| EMPLOYÉS. | Number employed. | Average daily wages. | Average days employed. |
|---|---|---|---|
| Total | 457 | $2.75 | 306 |
| Foremen | 12 | 5.06 | 327 |
| Mechanics | 22 | 4.90 | 322 |
| Laborers | 423 | 2.57 | 305 |

### EXPENDITURES.

| | |
|---|---|
| Total wages and salaries paid | $360,694.38 |
| Total supplies, materials, rent, and miscellaneous expenditures | 499,320.52 |
| Total expenditures, exclusive of cost of ore | 860,014.90 |

The contrast between the conditions under which the Montana smelters operated in 1889 and those prevailing in Colorado is well illustrated by the fact that the smelting mixture of the former yielded nearly 23 per cent of lead. The cost of treatment was apparently $12.04 per ton.

A third group of smelters in the Rocky mountains, working under conditions characteristically their own, is that of the Utah works. The returns from 3 establishments show the product of base bullion to be 12,908 short tons, and the quantity of ore treated 66,797 short tons.

The table following shows the number of employés engaged in lead smelting in Utah, average wages per day, and average number of days employed.

STATISTICS OF UTAH LEAD SMELTERS.

| EMPLOYÉS. (a) | Number employed. | Average daily wages. | Average days employed. |
|---|---|---|---|
| Total | 354 | $2.16 | 327 |
| Foremen | 5 | 3.58 | 365 |
| Mechanics | 8 | 3.03 | 308 |
| Laborers | 341 | 2.12 | 327 |

a Office force consists of 10 persons.

EXPENDITURES.

| | |
|---|---|
| Total wages paid | $253,805.60 |
| Salaries | 19,170.00 |
| Paid contractors | 6,532.05 |
| Supplies and materials | 362,347.14 |
| Rent, taxes, insurance, etc | 48,959.00 |
| Total expenditures, exclusive of cost of ore | 690,813.79 |

Special interest is attached to the operations of smelting establishments near the Mexican border in Texas and New Mexico. One of them did not begin operations until the close of the census year. The number of establishments was 3, the product of bullion was 13,733 short tons, and the quantity of ore treated was 79,168 short tons.

STATISTICS OF BORDER SMELTERS.

| EMPLOYÉS. (a) | Number employed. | Average daily wages. | Average days employed. |
|---|---|---|---|
| Total | 565 | $2.13 | 319 |
| Foremen | 9 | 4.04 | 322 |
| Mechanics | 12 | 3.45 | 325 |
| Laborers | 544 | 2.07 | 319 |

a Office force consists of 19 persons.

EXPENDITURES.

| | |
|---|---|
| Total wages paid | $244,674.72 |
| Salaries | 46,480.00 |
| Paid contractors | 1,350.00 |
| Supplies and materials | 479,654.48 |
| Rent, taxes, insurance, etc | 71,080.59 |
| Total expenditures, exclusive of cost of ore | 843,239.79 |

## LEAD DESILVERIZING AND REFINING.

Practically all the lead refining and desilverizing works are also engaged in lead smelting. In some cases lead refining is a minor part of the business, while in others ore smelting plays a very subordinate part. In some instances the parting of the precious metals is the principal business, while in others the smelting and refining is an operation subsidiary to the manufacture of sheet lead, shot, and white lead. Only a few works have found it possible, therefore, to give in detail the data relating to this one particular department. An aggregate of their special reports will suffice to illustrate the conditions affecting the industry. How large the smelting operations of the works are may be understood from the fact that 4 refineries made 33,638 tons of base bullion from 108,781 tons of lead ore, and that 2 others worked 21,775 tons of ore, without, however, being able to state their lead contents. All of them lie east of the Rocky mountains. The production of refined lead amounted to 95,287 tons, and the quantity of ore smelted was 7,425 tons. The total wages paid was $373,601.98.

The following table shows the number of employés, average wages per day, and average days employed:

| EMPLOYÉS. | Number employed. | Average daily wages. | Average days employed. |
|---|---|---|---|
| Total | 620 | $1.85 | 322 |
| Foremen | 15 | 3.48 | 318 |
| Mechanics | 80 | 2.39 | 352 |
| Laborers | 523 | 1.72 | 317 |
| Boys | 2 | 0.75 | 365 |

While it is true that 2 of the works included in the aggregate treated 7,425 tons of lead ore, it must be considered that the others which separated the two departments did not take account of the labor which would be employed in working up intermediate products in smelting them if the works did not also treat ore. Works with a product of 70,787 tons of refined lead reported that their expenditures for supplies, materials, etc., amounted to $307,784.36, while their outlays for rent, taxes, insurance. and all other expenditures amounted to $185,879.32. This does not include the salaries paid to officers, which could not well be distributed between the departments.

The following table summarizes the data for the whole lead smelting and desilverizing industry, California alone excepted. An effort has also been made to ascertain the stocks of base bullion and of refined lead in the hands of smelters and refiners in transit and in the hands of agents.

LEAD SMELTING AND REFINING WORKS.

| STATES AND TERRITORIES. | PRODUCT. | | | STOCK. | | | |
|---|---|---|---|---|---|---|---|
| | Base bullion. (Short tons.) | Refined lead. (Short tons.) | Fine copper in matte. (Pounds.) | Base bullion. (Short tons.) | | Refined lead. (Short tons.) | |
| | | | | January 1, 1889. | January 1, 1890. | January 1, 1889. | January 1, 1890. |
| The United States | ........ | 182,967 | 4,195,929 | 1,474 | 4,730 | 12,058 | 9,230 |
| California | ........ | 5,500 | ........ | ........ | ........ | ........ | ........ |
| Colorado | 73,205 | 2,784 | 1,360,617 | 290 | 3,138 | 18 | 168 |
| Idaho | 878 | ........ | ........ | ........ | ........ | ........ | ........ |
| Illinois, Iowa, Kansas, Missouri, and Wisconsin (soft lead) (*a*) | ........ | 29,258 | ........ | ........ | ........ | 4,058 | 5,267 |
| Illinois, Missouri, and Nebraska (desilverized) | 33,638 | 114,634 | 2,689,229 | 457 | 852 | 4,739 | 493 |
| Montana | 19,404 | ........ | ........ | ........ | ........ | ........ | ........ |
| Nevada | 1,328 | 1,104 | 23,218 | ........ | ........ | 1,280 | 1,402 |
| New Jersey, Pennsylvania, and Virginia | (*b*) | 28,507 | 122,865 | ........ | ........ | 1,963 | 1,883 |
| New Mexico and Texas | 13,733 | ........ | ........ | 116 | 81 | ........ | ........ |
| Utah | 12,908 | 1,180 | ........ | 611 | 659 | ........ | 17 |

| STATES AND TERRITORIES. | LABOR. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number employed. | | | | Average daily wages. | | | | Average days employed. | | | |
| | Foremen. | Mechanics. | Laborers. | Boys. | Foremen. | Mechanics. | Laborers. | Boys. | Foremen. | Mechanics. | Laborers. | Boys. |
| The United States | 173 | 354 | 5,595 | 9 | $3.98 | $2.93 | $2.15 | $0.50 | 337 | 322 | 307 | 336 |
| California | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Colorado | 61 | 71 | 2,019 | 2 | 3.99 | 3.52 | 2.48 | 0.75 | 361 | 353 | 321 | 365 |
| Idaho | 4 | 13 | 21 | ........ | 4.50 | 3.50 | 3.00 | ........ | 135 | 135 | 135 | ........ |
| Illinois, Iowa, Kansas, Missouri, and Wisconsin (soft lead) | 21 | 31 | 423 | 1 | 2.31 | 1.94 | 1.47 | 0.50 | 331 | 273 | 292 | 364 |
| Illinois, Missouri, and Nebraska (desilverized) | 45 | 151 | 1,333 | 2 | 4.33 | 2.48 | 1.76 | 0.75 | 360 | 344 | 289 | 365 |
| Montana | 14 | 26 | 493 | ........ | 5.05 | 4.72 | 2.63 | ........ | 328 | 322 | 306 | ........ |
| Nevada | 9 | 9 | 101 | ........ | 4.91 | 4.17 | 3.24 | ........ | 177 | 185 | 125 | ........ |
| New Jersey, Pennsylvania, and Virginia | 4 | 33 | 308 | 4 | 2.95 | 2.48 | 1.63 | 0.25 | 332 | 312 | 343 | 300 |
| New Mexico and Texas | 9 | 12 | 544 | ........ | 4.04 | 3.46 | 2.07 | ........ | 322 | 325 | 319 | ........ |
| Utah | 6 | 8 | 353 | ........ | 3.57 | 3.03 | 2.13 | ........ | 365 | 308 | 321 | ........ |

| STATES AND TERRITORIES. | EXPENDITURES. | | | | | | Office force. |
|---|---|---|---|---|---|---|---|
| | Total. | Wages. | Salaries. | Supplies and materials. | Rent, insurance, taxes, etc. | Contractors. | |
| The United States | $11,457,367.25 | $4,228,634.15 | $510,715.97 | $5,154,682.04 | $1,489,715.30 | $73,619.79 | 249 |
| California | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Colorado | 4,590,932.39 | 1,839,360.81 | 243,328.01 | 1,898,898.75 | 563,346.79 | 45,998.03 | 98 |
| Idaho | 81,798.57 | 17,110.00 | 3,300.00 | 61,388.57 | ........ | ........ | 2 |
| Illinois, Iowa, Kansas, Missouri, and Wisconsin (soft lead) | 580,210.00 | 206,540.69 | 19,680.00 | 184,174.71 | 166,631.95 | 3,182.65 | 15 |
| Illinois, Missouri, and Nebraska (desilverized) | 2,787,020.77 | 949,787.25 | 99,648.00 | 1,278,613.11 | 453,497.21 | 5,475.20 | 64 |
| Montana | 1,109,236.15 | 433,373.58 | 44,920.00 | 555,048.09 | 75,894.48 | ........ | 16 |
| Nevada | 174,663.73 | 50,694.71 | 4,935.00 | 89,034.02 | 30,000.00 | ........ | 3 |
| New Jersey, Pennsylvania, and Virginia | 585,000.71 | 229,133.44 | 29,254.96 | 238,622.17 | 76,908.28 | 11,081.86 | 22 |
| New Mexico and Texas | 843,239.79 | 244,674.72 | 46,480.00 | 479,654.48 | 71,080.59 | 1,350.00 | 19 |
| Utah | 705,265.14 | 257,958.95 | 19,170.00 | 369,248.14 | 52,356.00 | 6,532.05 | 10 |

*a* Produced also 1,250 tons sublimated lead.

*b* Quantity of base bullion produced from 21,775 tons of ore unknown.

The production of lead in the census year compares as follows with preceding years as reported in Mineral Resources of the United States:

PRODUCTION OF LEAD IN THE UNITED STATES FROM 1825 TO 1889.

[Short tons.]

| YEARS. | Total production. | Desilverized lead. | Nonargentiferous lead. | Percentage of desilverized lead. | YEARS. | Total production. | Desilverized lead. | Nonargentiferous lead. | Percentage of desilverized lead. |
|---|---|---|---|---|---|---|---|---|---|
| 1825 | 1,500 | | | | 1860 | 15,600 | | | |
| 1830 | 8,000 | | | | 1861 | 14,100 | | | |
| 1831 | 7,500 | | | | 1862 | 14,200 | | | |
| 1832 | 10,000 | | | | 1863 | 14,800 | | | |
| 1833 | 11,000 | | | | 1864 | 15,300 | | | |
| 1834 | 12,000 | | | | 1865 | 14,700 | | | |
| 1835 | 13,000 | | | | 1866 | 16,100 | | | |
| 1836 | 15,000 | | | | 1867 | 15,200 | | | |
| 1837 | 13,500 | | | | 1868 | 16,400 | | | |
| 1838 | 15,000 | | | | 1869 | 17,500 | | | |
| 1839 | 17,500 | | | | 1870 | 17,830 | | | |
| 1840 | 17,000 | | | | 1871 | 20,000 | | | |
| 1841 | 20,500 | | | | 1872 | 25,880 | | | |
| 1842 | 24,000 | | | | 1873 | 42,540 | 20,159 | 22,381 | 47.39 |
| 1843 | 25,000 | | | | 1874 | 52,080 | | | |
| 1844 | 26,000 | | | | 1875 | 59,640 | 34,909 | 24,731 | 58.53 |
| 1845 | 30,000 | | | | 1876 | 64,070 | 37,649 | 26,421 | 58.76 |
| 1846 | 28,000 | | | | 1877 | 81,900 | 50,748 | 31,152 | 61.96 |
| 1847 | 28,000 | | | | 1878 | 91,060 | 64,290 | 26,770 | 70.60 |
| 1848 | 25,000 | | | | 1879 | 92,780 | 64,650 | 28,130 | 69.68 |
| 1849 | 23,500 | | | | 1880 | 97,825 | 70,135 | 27,690 | 71.69 |
| 1850 | 22,000 | | | | 1881 | 117,085 | 86,315 | 30,770 | 73.72 |
| 1851 | 18,500 | | | | 1882 | 132,890 | 103,875 | 29,015 | 78.17 |
| 1852 | 15,700 | | | | 1883 | 143,957 | 122,157 | 21,800 | 84.86 |
| 1853 | 16,800 | | | | 1884 | 139,897 | 119,965 | 19,932 | 85.75 |
| 1854 | 16,500 | | | | 1885 | 129,412 | 107,437 | 21,975 | 83.02 |
| 1855 | 15,800 | | | | 1886 | 135,629 | 114,829 | 20,800 | 84.66 |
| 1856 | 16,000 | | | | 1887 | 160,700 | 135,552 | 25,148 | 84.35 |
| 1857 | 15,800 | | | | 1888 | 180,555 | 151,465 | 29,090 | 83.89 |
| 1858 | 15,300 | | | | 1889 | 182,967 | 153,709 | 29,258 | 84.01 |
| 1859 | 16,400 | | | | | | | | |

The product of the census year was 153,709 tons of desilverized lead, while the aggregate returns of the lead contents of the ores mined show 130,958 tons. The lead contents of the Mexican ore imported during 1889 were 26,570 short tons, leaving as the apparent product of the American mines 127,139 tons. The allowance for waste on the Mexican ores would moderately increase this quantity. Considering the loss in smelting and desilverizing the domestic ore, the aggregate quantity of the returns does not therefore cover the entire product, although it probably approaches it. In view of the quantities on the dumps, in stock at the smelters, and in transit, an exact balance can not be struck.

## THE ZINC SMELTING AND OXIDE INDUSTRY.

The smelting of zinc or spelter and the manufacture of oxide of zinc are so closely allied in the United States that it has been found impossible to separate the data relating to them and submit a report on each. The rolling of sheet zinc is confined to 1 establishment, whose report does not admit of separate presentation. The works in New Jersey and Pennsylvania carry on the manufacture of oxide and spelter in what is practically one plant, and in some instances the spelter produced is obtained by the distillation of unmarketable color. It has therefore been deemed expedient to embrace the industries named in one report.

### GEOGRAPHICAL.

The industry may be geographically grouped in 3 divisions: the western, embracing Illinois, Kansas, Missouri, and Wisconsin, the latter state making only oxide; the eastern, comprising New Jersey and Pennsylvania; and the southern, including Tennessee and Virginia.

The first group draws its supplies of ore from the southeastern Kansas, the southwestern Missouri, and the Wisconsin districts, the fuel in the majority of works being local coal. The New Jersey and Pennsylvania works obtain the greater part of their ore supply from local deposits, but occasionally draw upon distant markets. The New Jersey works make primarily oxide and relatively little spelter. The southern group, which has shown considerable development during the past few years, uses ores mined within easy access.

Nearly all the spelter produced east of the Alleghany mountains is exceptionally high in quality, some of it being exported to Europe for special purposes.

The following table embodies the data relating to the production of spelter and oxide of zinc:

PRODUCTION OF SPELTER AND OXIDE OF ZINC IN THE UNITED STATES.

[Short tons.]

| STATES. | Number of establishments. | PRODUCT. |  | STOCK. |  |  |  | ORE. |  |
|---|---|---|---|---|---|---|---|---|---|
|  |  | Spelter. | Oxide of zinc. | Spelter, January 1, 1889. | Spelter, January 1, 1890. | Oxide of zinc, January 1, 1889. | Oxide of zinc, January 1, 1890. | Ore treated. | Value of ore treated. |
| Total | 21 | 58, 860 | 16, 970 | 2, 781 | 2, 492 | 1, 425 | 1, 261 | 196, 309 | $4, 154, 403. 98 |
| Illinois and Wisconsin | 3 | *a*23, 860 | 3, 445 | 360 | 268 | 73 | 62 | 66, 141 | 1, 515, 939. 47 |
| Kansas | 6 | 13, 658 | .......... | 800 | 1, 075 | .......... | .......... | 41, 995 | 1, 178, 662. 73 |
| Missouri | 5 | 11, 077 | 351 | .......... | .......... | 100 | 140 | 20, 580 | 727, 503. 33 |
| New Jersey and Pennsylvania | 4 | 7, 075 | 13, 174 | 1, 041 | 845 | 1, 252 | 1, 059 | 53, 617 | 590, 738. 45 |
| Tennessee and Virginia | 3 | 3, 190 | .......... | 580 | 304 | .......... | .......... | 13, 976 | 141, 560. 00 |

| STATES. | Total wages and salaries. | LABOR. |  |  |  |  | OFFICE FORCE. |  |
|---|---|---|---|---|---|---|---|---|
|  |  | Total wages. (*b*) | Number of employés. |  |  |  | Number. | Salaries. |
|  |  |  | Foremen. | Mechanics. | Laborers. | Boys. |  |  |
| Total | $1, 565, 260. 43 | $1, 424, 980. 52 | 82 | 457 | 2, 024 | 127 | 95 | $140, 279. 91 |
| Illinois and Wisconsin | 575, 045. 48 | 484, 190. 83 | 25 | 66 | 800 | 86 | 54 | 90, 854. 65 |
| Kansas | 318, 115. 50 | 311, 150. 50 | 9 | 128 | 380 | 24 | 8 | 6, 965. 00 |
| Missouri | 256, 612. 62 | 237, 062. 62 | 8 | 210 | 225 | 2 | 11 | 19, 550. 00 |
| New Jersey and Pennsylvania | 299, 885. 39 | 281, 475. 13 | 16 | 41 | 438 | .......... | 17 | 18, 410. 26 |
| Tennessee and Virginia | 115, 601. 44 | 111, 101. 44 | 24 | 12 | 181 | 15 | 5 | 4, 500. 00 |

| STATES. | EXPENSES. |  |  | CAPITAL. |  |  |  |  |
|---|---|---|---|---|---|---|---|---|
|  | Expenses exclusive of wages, salaries, raw materials, and supplies. | Value of supplies and materials consumed, exclusive of ore. | Amount paid to contractors. | Total capital. | Land. | Buildings and fixtures. | Tools, implements, and machinery. | Cash. |
| Total | $210, 913. 39 | $653, 305. 75 | $15, 318. 84 | $4, 469, 386. 25 | $613, 000. 00 | $2, 019, 914. 77 | $975, 856. 50 | $860, 614. 98 |
| Illinois and Wisconsin | 69, 996. 88 | 261, 924. 22 | .......... | 1, 518, 920. 68 | 139, 000. 00 | 799, 000. 00 | 357, 766. 13 | 223, 154. 55 |
| Kansas | 42, 900. 00 | 48, 500. 00 | .......... | 538, 500. 00 | 64, 000. 00 | 281, 000. 00 | 38, 500. 00 | 155, 000. 00 |
| Missouri | 44, 281. 00 | 81, 187. 53 | .......... | 527, 321. 36 | 40, 000. 00 | 389, 914. 77 | 60, 666. 00 | 36, 740. 59 |
| New Jersey and Pennsylvania | 43, 885, 51 | 210, 344. 00 | 15, 318. 84 | 1, 644, 644. 21 | 350, 000. 00 | 410, 000. 00 | 449, 924. 37 | 434, 719. 84 |
| Tennessee and Virginia | 9, 850. 00 | 51, 350. 00 | .......... | 240, 000. 00 | 20, 000. 00 | 140, 000. 00 | 69, 000. 00 | 11, 000. 00 |

| STATES. | LENGTH OF EMPLOYMENT AND AVERAGE WAGES. |  |  |  |  |  |  |  | POWER. |  |  | Number of animals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | Foremen. |  | Mechanics. |  | Laborers. |  | Boys. |  | Number of boilers. | Horse power of boilers. | Number of engines. |  |
|  | Average daily wages. | Average number of days employed. | Average daily wages. | Average number of days employed. | Average daily wages. | Average number of days employed. | Average daily wages. | Average number of days employed. |  |  |  |  |
| Total | $2. 62 | 331 | $1. 93 | 333 | $1. 48 | 324 | $0. 68 | 287 | 115 | 5, 171 | 33 | 165 |
| Illinois and Wisconsin | 3. 00 | 326 | 2. 16 | 274 | 1. 24 | 316 | 0. 70 | 280 | 37 | 1, 839 | 11 | 44 |
| Kansas | 2. 45 | 356 | 1. 93 | 357 | 1. 74 | 336 | 0. 75 | 306 | 13 | 370 | 6 | 37 |
| Missouri | 2. 59 | 331 | 1. 74 | 345 | 1. 76 | 304 | 0. 60 | 310 | 39 | 1, 800 | 7 | 25 |
| New Jersey and Pennsylvania | 2. 38 | 343 | 2. 36 | 298 | 1. 60 | 342 | .......... | .......... | 24 | 1, 102 | 7 | 59 |
| Tennessee and Virginia | 2. 46 | 320 | 2. 40 | 294 | 1. 35 | 314 | 0. 50 | 240 | 2 | 60 | 2 | .......... |

*a* Includes 9,389 tons of sheet zinc.

*b* Wages paid during the year.

The production of spelter in the United States has kept pace fairly well with the rapid expansion in the consumption, while, aside from the quantity used for sheet, zinc is called for by galvanizers of iron sheets and wire and by brass manufacturers. During the year 1889 the amount used for these purposes was about 50,000 short tons.

According to the reports published in Mineral Resources of the United States for years previous to 1889, the production has been as follows for a series of years:

PRODUCTION OF SPELTER IN THE UNITED STATES, BY YEARS.

| | SHORT TONS. | | SHORT TONS. |
|---|---|---|---|
| 1873 | 7, 343 | 1885 | 40, 688 |
| 1875 | 15, 833 | 1886 | 42, 641 |
| 1880 (census year ending May 31) | 23, 239 | 1887 | 50, 340 |
| 1882 | 33, 765 | 1888 | 55, 903 |
| 1883 | 36, 872 | 1889 (census statistics) | 58, 860 |
| 1884 | 38, 544 | | |

Grouped by states, the production has been as follows for the years given:

PRODUCTION OF SPELTER, BY STATES.

[Short tons.]

| STATES. | 1882. | 1883. | 1884. | 1885. | 1886. | 1887. | 1888. | 1889. |
|---|---|---|---|---|---|---|---|---|
| Total | 33, 765 | 36, 872 | 38, 544 | 40, 688 | 42, 641 | 50, 340 | 55, 903 | 58, 860 |
| Eastern and southern states | 5, 698 | 5, 340 | 7, 861 | 8, 082 | 6, 762 | 7, 446 | 9, 561 | 10, 265 |
| Illinois | 18, 201 | 16, 792 | 17, 594 | 19, 427 | 21, 077 | 22, 279 | 22, 445 | 23, 860 |
| Kansas | 7, 366 | 9, 010 | 7, 859 | 8, 502 | 8, 932 | 11, 955 | 10, 432 | 13, 658 |
| Missouri | 2, 500 | 5, 730 | 5, 230 | 4, 677 | 5, 870 | 8, 660 | 13, 465 | 11, 077 |

## LABOR AND WAGES.

The most striking fact in connection with the data presented on the labor engaged in the spelter and oxide of zinc industries is the full employment given to it. This is clearly shown in the table giving the length of employment. The works in the majority of cases have not reported the number of days employed with mathematical accuracy, but the schedules confirm the general result, as the question calling for a statement of the causes of idleness has almost invariably received the reply that the establishments had been busy throughout the whole year. Since in the distillation of zinc the furnaces must be operated on Sunday, the average is naturally high. None of the works reported any strikes or lockouts.

It should be noted that the reports differ in their classification of labor. Some of the managers have included under "Mechanics" all the skilled labor in their establishments, while others have reported only carpenters, masons, blacksmiths, etc., as belonging under that head, placing the furnace men, etc., under the head of "Laborers". In the latter case the figures reported show that the special class of labor, in the particular instances in which this system was followed, received wages only slightly higher than those of common labor and as low as those paid in other sections for the latter. This explains the apparent anomaly in the case of Missouri, where the average daily wages of mechanics was only $1.74, while that of common laborers was $1.76.

# QUICKSILVER.

# QUICKSILVER.

BY JAMES BUTTERWORTH RANDOL.

## PRESENT STATE OF THE INDUSTRY.

The quicksilver industry during the last decade has remained in the same depressed condition. No new discoveries have been made, and the old mines are becoming exhausted to such a degree as to indicate a rather doubtful future notwithstanding the somewhat improved prices, which should tend to a new stimulus in prospecting as well as in producing.

The New Almaden mine, once the proud rival of the Almaden mine in Spain, has given up its second place to the Idria mine in Austria, and the prospects for regaining its lost rank are not very encouraging. The same may be said of the other California mines. All have had similar experience, as shown by the table below. The New Almaden, with a production of 23,465 flasks in 1880, produced in 1889 only 13,100 flasks. The Sulphur Bank, with 10,706 flasks in 1880, produced only 2,283 in 1889; the Great Western produced 6,442 flasks in 1880 against 556 in 1889, while the Guadalupe, a mine in 1880 producing 6,670 flasks, has produced nothing since 1885.

COMPARATIVE TABLE OF QUICKSILVER PRODUCTION IN 1889 AND 1880.

[Flasks.]

| COMPANIES. | 1889. | 1880. | Increase. | Decrease. |
|---|---|---|---|---|
| Total | a26,484 | 59,926 | 2,114 | 35,556 |
| New Almaden | 13,100 | 23,465 | | 10,365 |
| Ætna<br>Napa Consolidated | 4,590 | 4,416 | 174 | |
| Great Western | 556 | 6,442 | | 5,886 |
| Sulphur Bank | 2,283 | 10,706 | | 8,423 |
| New Idria | 980 | 3,209 | | 2,229 |
| Great Eastern | 1,345 | 1,279 | 66 | |
| Redington | 812 | 2,139 | | 1,327 |
| Guadalupe | | 6,670 | | 6,670 |
| Bradford | 1,874 | | 1,874 | |
| Various companies | a944 | 1,600 | | 656 |

a Includes 20 flasks from Oregon.

This table shows improvement only in 3 cases, while in all the others a very serious decrease has taken place, the aggregate of production having decreased 55.84 per cent.

The prices for quicksilver, on the contrary, have shown an improvement, the highest and lowest quotations per flask in 1880 being $34.45 and $27.55, against $50 and $40, respectively, in 1889, a total improvement of 45.16 per cent. This improvement in prices has given some encouragement to prospectors, but with no satisfactory results. The total approximate valuation during the decade from 1870 to 1879, inclusive, was $24,322,500, against $13,480,500 in the last decade—a serious loss, with impoverished mining properties.

The world's production in 1880 was 122,536 flasks, of which the California mines produced nearly one-half, while with a total production of 113,842 flasks in 1889 California only claims 23.25 per cent.

New utilizations for the metal have not been discovered, and the general depression in the Comstock mines has had a very depressing effect on the quicksilver market. The shipments to China and South America ceased altogether in 1889, and shipments to other countries have largely decreased. The total foreign shipments from San Francisco in 1880 were 34,648 flasks, against 5,189 flasks in 1889.

## CENSUS STATISTICS.

During the calendar year 1889 there were 26,464 flasks, or 2,024,496 pounds, or 1,012 short tons of quicksilver produced in California. About 20 flasks, less than $1,000 in value, were produced in Oregon. The product is notably less than the usual yield. In 1888, 33,250 flasks were produced.

### ESTABLISHMENTS.

In the following table, under the heading of "Productive mines and furnaces", is included every establishment in the United States where cinnabar ore is known to have been mined and quicksilver produced therefrom to the amount of $1,000 or more during the period under review. The nonproductive mines and furnaces include establishments the stoppage of which was caused, among other reasons, by litigation, by low prices for quicksilver and the consequent unprofitable results for the time being, or by lack of sufficient capital and experience to pursue a hazardous industry. It is considered probable that all of those establishments now closed and unproductive will resume work when higher and more remunerative prices for quicksilver can be obtained.

The productive mines and furnaces, with few exceptions, were operated continuously throughout the year, omitting holidays and Sundays.

LOCATION AND NUMBER OF ALL THE QUICKSILVER ESTABLISHMENTS, BY STATES AND COUNTIES.

| STATES. | Counties. | PRODUCTIVE. | | NONPRODUCTIVE. | |
|---|---|---|---|---|---|
| | | Mines. | Furnaces. | Mines. | Furnaces. |
| Total | | 11 | 36 | 6 | 7 |
| California | Lake | 3 | 12 | | |
| Do | Merced | 1 | (*a*) | | |
| Do | Napa | 4 | 12 | | |
| Do | San Benito | 1 | 3 | | |
| Do | Santa Clara | 1 | 7 | 1 | 4 |
| Do | Sonoma | 1 | 2 | | |
| Do | Siskiyou | | | 1 | (*a*) |
| Do | Trinity | | | 1 | |
| Oregon | Douglas | | | 3 | 3 |

*a* One retort.

The productive mines and active furnaces employed 937 operatives, of whom 416 were engaged on surface work and 521 were employed underground. The other mines and furnaces employed 24 men, making a total of 961 employés, as shown in the following table:

NUMBER OF EMPLOYÉS.

| EMPLOYÉS. | Total. | Productive mines and furnaces. | Nonproductive mines and furnaces. |
|---|---|---|---|
| Total | 961 | 937 | 24 |
| Men | 956 | 932 | 24 |
| Women | 1 | 1 | |
| Boys | 4 | 4 | |
| Total on surface | 434 | 416 | 18 |
| Total underground | 527 | 521 | 6 |

### PRODUCTION STATISTICS.

Of 95,714 tons (2,000 pounds each) of cinnabar ore mined, 92,964 tons were roasted, producing 26,464 flasks of quicksilver, each containing a standard quantity of 76.5 pounds avoirdupois. Of the 11 establishments working ore, 1 reported only 200 tons produced and worked in retorts, with an average yield of 2.295 per cent, the highest percentage returned. The lowest average yield was 0.286 per cent, and the average percentage yield in quicksilver for all the ore roasted was 1.089. The largest quantities of ore produced and roasted by a single establishment were, respectively, 28,007 and 28,887 tons, and the quantity of quicksilver produced at the several works ranged from 120 to 13,100 flasks.

The following table exhibits the quantity of ore produced and roasted in 1889, the number of flasks of quicksilver produced, and the percentage of yield:

YIELD OF QUICKSILVER FROM ORES ROASTED IN 1889.

| NUMBER OF ESTABLISHMENTS. | Ore produced. (Short tons.) | Ore roasted. (Short tons.) | Quicksilver produced. (Flasks.) | Yield. (Per cent.) |
|---:|---:|---:|---:|---:|
| 1 | 7, 168 | 7, 168 | 1, 874 | 1. 000 |
| 1 | 9, 880 | 9, 880 | 2, 283 | 0. 884 |
| 1 | 7, 440 | 7, 440 | 556 | 0. 286 |
| 1 | 200 | 200 | 120 | 2. 295 |
| 1 | 4, 742 | 3, 992 | 812 | 0. 778 |
| 1 | 23, 500 | 23, 500 | 4, 590 | 0. 747 |
| 1 | 3, 400 | 3, 400 | 804 | 0. 905 |
| 1 | 3, 377 | 3, 377 | 980 | 1. 110 |
| 1 | 28, 007 | 28, 887 | 13, 100 | 1. 735 |
| 1 | 7, 000 | 5, 120 | 1, 345 | 1. 005 |
| 1 | 1, 000 | ........ | ........ | ........ |
| 11 | 95, 714 | 92, 964 | *a*26, 464 | 1. 089 |

*a* One mine in Oregon produced 20 flasks, the total product in that state; they are not included, being less than $1,000 in value.

## EXPENDITURES.

The following table shows the value of supplies of all kinds consumed during the year 1889, the aggregate of all wages paid, total of all other expenditures for mines and works, including rent, taxes, etc., number of flasks of quicksilver produced, and average cost per flask:

EXPENDITURES IN THE PRODUCTION OF QUICKSILVER IN 1889. NUMBER OF FLASKS PRODUCED, ETC.

| NUMBER OF ESTABLISHMENTS. | Value of all supplies. | Aggregate of all wages. | Total of all other expenditures. | Number of flasks of quicksilver produced. | Average cost per flask. |
|---:|---:|---:|---:|---:|---:|
| 1 | $53, 567 | $104, 608 | $760 | 4, 590 | $34. 63 |
| 1 | 5, 975 | 8, 060 | ........ | ........ | (*a*) |
| 1 | *b*4, 000 | 20, 936 | 750 | 804 | 31. 95 |
| 1 | 4, 000 | 12, 591 | 1, 000 | 812 | 21. 66 |
| 1 | 9, 564 | 43, 241 | 1, 042 | 1, 874 | 28. 73 |
| 1 | 21, 973 | 47, 208 | 2, 507 | 2, 283 | 31. 40 |
| 1 | 9, 034 | 25, 352 | 2, 167 | 556 | 65. 74 |
| 1 | 1, 500 | 2, 250 | ........ | 120 | 31. 25 |
| 1 | 3, 114 | 27, 546 | 79 | 980 | 31. 37 |
| 1 | 86, 428 | 204, 341 | 26, 826 | 15, 100 | 31. 88 |
| 1 | 20, 467 | 30, 156 | 359 | 1, 345 | 37. 90 |
| 11 | 219, 622 | 626, 289 | 35, 490 | 26, 464 | 33. 31 |

*a* Ore mined, but none roasted, and therefore omitted in average cost per flask.
*b* Estimated; correct amount unobtainable.

From the above table it will be seen that at 11 active establishments there were expended $219,622 for supplies, $626,289 for wages, and $35,490 for other expenses, embracing taxes, rent, interest, etc., making a total of $881,401, showing that 71.05 per cent was paid for wages, 24.92 per cent for supplies, and 4.03 per cent for all other expenses. Of the amount paid for wages the office force absorbed $34,966, and there were paid to foremen, mechanics, miners, furnace hands, and laborers $591,323.

## PRICES.

The cost per flask of quicksilver produced ranged from $65.74 to $21.66, the average cost for all being $33.31. The following table gives the highest and lowest price monthly for quicksilver:

PRICE OF QUICKSILVER IN SAN FRANCISCO DURING 1889.

| MONTHS. | Highest. | Lowest. | MONTHS. | Highest. | Lowest. | MONTHS. | Highest. | Lowest. |
|---|---:|---:|---|---:|---:|---|---:|---:|
| January | $43. 00 | $41. 50 | May | $45. 00 | $41. 00 | September | $47. 50 | $47. 00 |
| February | 42. 00 | 41. 50 | June | 50. 00 | 46. 50 | October | 47. 00 | 46. 50 |
| March | 41. 00 | 40. 00 | July | 47. 50 | 46. 50 | November | 48. 00 | 46. 00 |
| April | 41. 00 | 40. 00 | August | 47. 50 | 46. 00 | December | 47. 50 | 47. 00 |

For the year the highest price per flask for quicksilver was $50 and the lowest $40. The total valuation of the year's production was $1,190,500. The difference between the cost, $881,401, and value, $1,190,500, is $309,099, which may be regarded as the profit on the year's work, based on the returns collected. The difference between average cost and average sale price was $11.69 per flask.

The establishment producing quicksilver at a cost of $65.74 per flask met with a serious loss on its output, and no establishment made a profit commensurate with the risks attending the mining of cinnabar, its manufacture into quicksilver, and finding for it a market in competition with rich and important establishments carried on by foreign governments.

### WAGES.

The wages in the table appended show considerable variations, depending largely upon the locality of the work, its importance, and the degree of skill required for its performance. On work at surface foremen were reported to earn daily wages ranging from $10.33 to $2.66; mechanics, $3.60 to $2.05; laborers, $2 to $1.18, the last-named rate being for Chinamen. Boys under 16 years of age, of whom only 4 were employed, none underground, earned from $1 to 75 cents.

The following table gives the number and classification of employés on surface (excepting the office force), daily wages, and number of days worked during the year:

NUMBER OF EMPLOYÉS ABOVE GROUND, WAGES, ETC., IN QUICKSILVER MINING.

| NUMBER OF ESTABLISHMENTS. | FOREMEN. | | | MECHANICS. | | |
|---|---|---|---|---|---|---|
| | Average number employed daily. | Average wages per day. | Average number of days worked. | Average number employed daily. | Average wages per day. | Average number of days worked. |
| 1 | 1 | $2.90 | 365 | [a]5 | $2.80 | 301 |
| 1 | 2 | 10.33 | 360 | 5 | 2.50 | 360 |
| 1 | 1 | 2.81 | 157 | 3 | 3.20 | 90 |
| 1 | .......... | .......... | .......... | 1 | 3.60 | 300 |
| 1 | 4 | 2.86 | 349 | [b]42 | 2.38 | 306 |
| 1 | 1 | 2.75 | 340 | 5 | 3.00 | 340 |
| 1 | .......... | .......... | .......... | 2 | 2.05 | 320 |
| 1 | 2 | 2.66 | 365 | .......... | .......... | .......... |
| 8 | 11 | [c]10.33<br>[d]2.66 | [c]365<br>[d]157 | 63 | [c]3.60<br>[d]2.05 | [c]360<br>[d]90 |

| NUMBER OF ESTABLISHMENTS. | LABORERS. | | | BOYS UNDER 16 YEARS. | | |
|---|---|---|---|---|---|---|
| | Average number employed daily. | Average wages per day. | Average number of days worked. | Average number employed daily. | Average wages per day. | Average number of days worked. |
| 1 | [e]11 | $1.38 | 300 | .......... | .......... | .......... |
| 1 | 15 | 1.75 | 360 | .......... | .......... | .......... |
| 1 | 6 | 2.00 | 300 | .......... | .......... | .......... |
| 1 | 17 | 1.73 | 265 | .......... | .......... | .......... |
| 1 | [f]87 | 1.18 | 284 | .......... | .......... | .......... |
| 1 | [g]98 | 1.94 | 281 | 3 | $0.75 | 187 |
| 1 | 38 | 2.00 | 340 | 1 | 1.00 | 310 |
| 1 | [f]12 | 1.30 | 300 | .......... | .......... | .......... |
| 1 | [f]2 | 1.37 | 308 | .......... | .......... | .......... |
| 9 | 286 | [c]2.00<br>[d]1.18 | [c]360<br>[d]265 | 4 | [c]1.00<br>[d]0.75 | [c]310<br>[d]187 |

[a] Mechanics comprise engineers, $2.90; blacksmiths, $2.90; and furnace men, $2.65 per day.

[b] Mechanics comprise carpenters, $3; masons, $5; blacksmiths, $2.10; helpers, $1.03; engine drivers, $2.39; machinists and helpers, $3.67 as their average earnings per day.

[c] Highest.

[d] Lowest.

[e] Laborers embrace men sorting ore, $1.25; teamsters, $1.65 per day.

[f] Chinese.

[g] Laborers comprise furnace hands, $2 to $2.25; ordinary laborers, $2; ore cleaners, $1.75 per day.

One establishment reported 42 men employed on surface and underground work without classification or number of days employed, miners at $2.10 and laborers at $1.75 per day. Another establishment reported 11 white men on surface without classification, at $2.80 per day for 352 days. These establishments were not included in the tables.

The tables on the following page exhibit the number and classification of workers underground, their daily wages, and the number of days worked during the year. For foremen at underground work the average wages ranged from $4.68 to $2.75 per day. Miners earned an average of $2.67 to $1.22, the lowest rate being for Chinamen, of whom a few were employed at small establishments.

## TOTAL NUMBER OF EMPLOYÉS UNDERGROUND.

| | |
|---|---|
| Foremen | 9 |
| Miners | 378 |
| Laborers | *a*134 |

*a* 53 unclassified, of which 32 were reported as Chinese, without classification, 362 days, at $1.17 per day.

## WAGES OF FOREMEN AND MINERS UNDERGROUND.

| NUMBER OF ESTABLISHMENTS. | FOREMEN. | | | MINERS. | | |
|---|---|---|---|---|---|---|
| | Average number employed daily. | Average wages per day. | Average number of days worked. | Average number employed daily. | Average wages per day. | Average number of days worked. |
| 1 | 1 | $2. 90 | 340 | *a*6 | $2. 40 | 300 |
| 1 | 1 | 4. 00 | 360 | 20 | 2. 67 | 360 |
| 1 | .............. | .............. | .............. | 22 | 2. 45 | 263 |
| 1 | 1 | 2. 75 | 110 | *b*5 | 1. 22 | 40 |
| 1 | 2 | 4. 68 | 306 | *c*233 | 2. 66 | 279 |
| 1 | 3 | 3. 06 | 340 | *b*80 | 1. 25 | 340 |
| 1 | 1 | 4. 50 | 316 | 6 | 2. 05 | 284 |
| 1 | .............. | .............. | .............. | 6 | 1. 50 | 336 |
| 8 | 9 | *d*4. 68<br>*e*2. 75 | *d*360<br>*e*110 | 378 | *d*2. 67<br>*e*1. 22 | *d*360<br>*e*40 |

*a* Miners embrace timbermen and machine drill men.
*b* Chinese.
*c* Miners comprise tributers, $2.41; drillers per foot on contract, $2.33; drifting on contract, $2.80; timbermen, $3; blasters, $2.75 per day.
*d* Highest.
*e* Lowest.

## WAGES OF LABORERS UNDERGROUND.

| NUMBER OF ESTABLISHMENTS. | LABORERS. | | |
|---|---|---|---|
| | Average number employed daily. | Average wages per day. | Average number of days worked. |
| 1 | *a*24 | $1. 90 | 290 |
| 1 | 5 | 2. 17 | 360 |
| 1 | 1 | 2. 00 | 300 |
| 1 | 19 | 2. 09 | 267 |
| 1 | *a*25 | 1. 50 | 340 |
| 1 | 3 | 1. 65 | 315 |
| 1 | 4 | 1. 35 | 336 |
| 7 | 81 | *b*2. 17<br>*c*1. 35 | *b*360<br>*c*267 |

*a* Laborers embrace helpers and hand drillers at $1.90 per day.
*b* Highest.
*c* Lowest.

The following table gives the number of office force, total pay of same, total wages of all other employés, and the aggregate wages paid to all employés:

## NUMBER OF OFFICE FORCE, TOTAL WAGES, ETC.

| NUMBER OF ESTABLISHMENTS. | Number of office force employed. | Total wages paid to all employés. | Total pay of office force. | All other wages. |
|---|---|---|---|---|
| 1 | .............. | $25, 352 | .............. | $25, 352 |
| 1 | .............. | 2, 250 | .............. | 2, 250 |
| 1 | .............. | 20, 936 | .............. | 20, 936 |
| 1 | 1 | 30, 156 | $800 | 29, 356 |
| 1 | 3 | 43, 241 | 2, 520 | *a* 40, 721 |
| 1 | 2 | 27, 546 | 3, 900 | 23, 646 |
| 1 | 2 | 47, 208 | 3, 366 | 43, 842 |
| 1 | 7 | 304, 341 | 17, 560 | *b* 286, 781 |
| 1 | 3 | 104, 608 | 5, 200 | 99, 408 |
| 1 | 1 | 12, 591 | 1; 200 | *d* 11, 391 |
| 1 | 1 | 8, 060 | 420 | 7, 640 |
| 11 | *c* 20 | 626, 289 | 34, 966 | 591, 323 |

*a* $300 paid to contractors included.
*b* $10,606 paid to contractors included.
*c* Includes 1 female, the only one employed.
*d* $375 paid to contractors included.

During the census decade, 1880–1889, inclusive, there were no strikes or labor troubles of any kind in any of the mines and works, and fair wages for good work was the rule for employers and employés.

## POWER.

The active establishments employed 62 steam motors with a capacity of 2,190 horse power, 1 electric dynamo and motor of 4 horse power, and 1 water wheel of 3 horse power, a total of 2,197 horse power in motors. 54 boilers were employed, with a capacity of 2,438 horse power. 247 animals were also reported as employed, but it is probable a greater number were in use. The details for the respective establishments are shown in the following table:

### POWER USED IN QUICKSILVER MINING AND REDUCTION.

| NUMBER OF ESTABLISHMENTS. | STEAM MOTORS. | | OTHER MOTORS. | | BOILERS. | | Number of animals. |
|---|---|---|---|---|---|---|---|
| | Number. | Horse power. | Number. | Horse power. | Number. | Horse power. | |
| 1 | 2 | 50 | ........ | ........ | 2 | 30 | 4 |
| 1 | 5 | 230 | ........ | ........ | 5 | 140 | 4 |
| 1 | 3 | 90 | ........ | ........ | 2 | 125 | 4 |
| 1 | 2 | 150 | ........ | ........ | 5 | 155 | 12 |
| 1 | 2 | 50 | ........ | ........ | 4 | 100 | 12 |
| 1 | 7 | 185 | ........ | ........ | 5 | 400 | 15 |
| 1 | 29 | 1,000 | 2 | a7 | 23 | 1,088 | 114 |
| 1 | 5 | 170 | ........ | ........ | 3 | 200 | 52 |
| 1 | 7 | 265 | ........ | ........ | 5 | 200 | 20 |
| 1 | ........ | ........ | ........ | ........ | ........ | ........ | 10 |
| 10 | 62 | 2,190 | 2 | 7 | 54 | 2,438 | 247 |

*a* One water wheel of 3 horse power, and 1 dynamo and motor of 4 horse power.

The following statement gives an estimated valuation of the active mines and works as nearly as the same could be ascertained:

### VALUE OF QUICKSILVER ESTABLISHMENTS.

| NUMBER OF ESTABLISHMENTS. | Total capital. (*a*) | Mines and real estate. | Furnaces, houses, and other surface improvements. | Machinery, supplies, tools, and live stock. | Quicksilver unsold. | Bills and accounts receivable. | Other assets. |
|---|---|---|---|---|---|---|---|
| 1 | $590,553 | $276,530 | $50,000 | $58,850 | $96,660 | ........ | $108,513 |
| 1 | 50,000 | 30,000 | 13,300 | 2,000 | 4,700 | ........ | ........ |
| 1 | 108,460 | 65,000 | 25,000 | 10,000 | 6,460 | ........ | 2,000 |
| 1 | 24,335 | 6,940 | 14 000 | 3,300 | 95 | ........ | ........ |
| 1 | 32,500 | 20,000 | 5,000 | 5,000 | 2,500 | ........ | ........ |
| 1 | 155,000 | 100,000 | 25,000 | 30,000 | ........ | ........ | ........ |
| 1 | 27,000 | 12,000 | 5,000 | 10,000 | ........ | ........ | ........ |
| 1 | 50,466 | 20,000 | 10,000 | 5,000 | 859 | $9,664 | [illegible], 943 |
| 1 | 122,900 | 50,000 | 25,000 | 10,000 | 2,900 | 25,000 | 10,000 |
| 1 | 59,900 | 25,000 | 15,000 | 10,000 | 9,900 | ........ | ........ |
| *b* 6 | 112,000 | 75,000 | 35,000 | 2,000 | ........ | ........ | ........ |
| 16 | 1,333,114 | 680,470 | 222,300 | 146,150 | 124,074 | 34,664 | 125,456 |

*a* Estimated.

*b* Nonproductive.

Some mine owners placed a higher valuation on their mines and improvements than is given in the foregoing statement, but it is preferred to take what may be considered a conservative opinion of the values as of December 31, 1889. Undoubtedly the original investments in the properties were many times the amounts of present estimates, but it must be remembered that mines are generally decreased in value by the extraction of ore for a long period of continuous work, which has been the case with the quicksilver establishments of the United States.

## STATISTICS FOR EARLIER PERIODS.

The earliest records relating to the production of quicksilver in California are for 1850, cinnabar having been first discovered there in 1845. But very little quicksilver was produced prior to 1850, when active work was commenced at New Almaden. Outside of California quicksilver has been produced in 2 localities in the United States: in Oregon, to the extent of 2,000 flasks, and in Utah, where about 200 flasks were reported.

## EARLIER CENSUS INFORMATION.

Examination of the United States census reports from 1790 to 1880 in relation to the quicksilver industry shows that no account had been taken of the industry prior to 1860. At that date and in the subsequent reports for 1870 and 1880 the information is quite limited. The following is a summary of the information relating to cinnabar and quicksilver in the census reports prior to 1890, all for the state of California, except the instances noted for 1880:

### QUICKSILVER STATISTICS OF THE CENSUS OF 1860. (a)

| COUNTIES. | Number of establishments. | Capital invested. | Cost of raw material. | Number of hands employed. | Cost of labor. | Value of product. |
|---|---|---|---|---|---|---|
| Total | 3 | $3, 112, 000 | $166, 100 | 335 | $159, 000 | $382, 000 |
| Fresno (b) | 1 | 100, 000 | 15, 400 | 110 | 87, 000 | 152, 000 |
| Santa Clara | 2 | 3, 012, 000 | 150, 700 | 225 | 72, 000 | 230, 000 |

a Census report for 1860, "Manufactures of the United States", pages 24, 28, 36, 722.

b Should be Monterey county.

The census of 1870, in the volume of industry and wealth, contains 3 tabular statements relating to quicksilver and cinnabar, the latter being the ore from which quicksilver is extracted by roasting, and not by smelting, as the table indicates. It will be noted that of the 3 tables the last gives figures largely different from the first 2, although apparently embracing the same subject, and it would appear that all are without real value for want of accuracy.

### QUICKSILVER STATISTICS OF THE CENSUS OF 1870. (a)

| | |
|---|---|
| Establishments | 4 |
| Steam engines: | |
| Number | 1 |
| Horse power | 64 |
| Water wheels: | |
| Number | 1 |
| Horse power | 12 |
| Employés | 256 |
| Males | 248 |
| Youth | 8 |
| Capital | $3, 500, 000 |
| Wages | $181, 000 |
| Materials | $837, 800 |
| Products | $1, 027, 680 |

a Mechanical and manufacturing industries, quicksilver smelted.

### SMELTING INDUSTRIES, BY COUNTIES.

| COUNTIES. | Establishments. | Employés. | Capital. | Wages. | Materials. | Products. |
|---|---|---|---|---|---|---|
| Total | 4 | 256 | $3, 500, 000 | $181, 000 | $837, 800 | $1, 027, 680 |
| Fresno (a) | 1 | 87 | 250, 000 | 70, 000 | 338, 600 | 420, 000 |
| Lake | 1 | 75 | 250, 000 | 50, 000 | 100, 500 | 166, 230 |
| Santa Clara | 2 | 94 | 3, 000, 000 | 61, 000 | 398, 700 | 441, 450 |

a Should be Monterey county.

### CINNABAR INDUSTRIES.

| COUNTIES. | Establishments. | STEAM ENGINES. | | EMPLOYÉS. | | | | Capital. | Wages. | Materials. | Products. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Number. | Horse power. | Total. | Men above ground. | Men below ground. | Boys above ground. | | | | |
| Total | 4 | 3 | 71 | 811 | 410 | 382 | 19 | $11, 900, 000 | $599, 000 | $30, 700 | $817, 700 |
| Fresno (a) | 1 | ........ | ........ | 263 | 263 | ........ | ........ | 150, 000 | 215, 000 | 2, 000 | 330, 000 |
| Lake | 1 | ........ | ........ | 75 | 75 | ........ | ........ | 250, 000 | 50, 000 | 6, 500 | 100, 000 |
| Santa Clara | 2 | 3 | 71 | 473 | 72 | 382 | 19 | 11, 500, 000 | 334, 000 | 22, 200 | 387, 700 |

a Should be Monterey county.

On page 767 of volume III, Ninth Census reports, the total of the above figures is given as the amount of cinnabar produced in the United States.

In the Tenth Census reports of 1880 all that relates to quicksilver and cinnabar is to be found in volume XIII, "Precious metals". No statements of production, employés, cost, etc., are given, but the localities of important deposits are mentioned, and will be referred to for comparison:

> Cinnabar is the only quicksilver ore of commercial importance, and it is found in numerous localities in California, in the coast range of mountains for 100 or 150 miles north and south of San Francisco, not in well-defined veins, but commonly in irregular bodies distributed through metamorphic rocks of cretaceous age. The usual gangue minerals are quartz, calcite, and magnesite.
>
> In the New Almaden mine, which has been much more extensively worked than any other in the state, these bodies appear, from a model constructed by the owners, to lie on a curved surface, indicating a geometrical relation between the positions of the several ore bodies, though an obscure one. At this mine the masses of ore are usually connected by tiny seams of the same material. There is a strong similarity between this mode of occurrence and that of many lead-ore deposits on the limestone, and it may be that the problem of their true character is the same.
>
> The quicksilver country north of San Francisco is a volcanic region, while to the south volcanic rocks are subordinate in some localities and wanting in others. No general inference as to the genesis or age of the deposits can be drawn without further investigation, while the great similarity in the association of minerals suggests similar origin for most of them. (*a*)

As in the census reports of 1860 and 1870, in 1880 Fresno county is credited with the possession of the New Idria mine, which at the last date properly belongs to and is included in the boundaries of the adjoining county of San Benito. This mine is yet in operation, though no longer of importance. (*b*) The ore is distributed in metamorphic sandstone and shale (*c*). The mines mentioned as in Lake county, the Great Western and Sulphur Bank, are still operated with diminished results (*b*), and in Napa county (*d*) the Redington mine is no longer "one of the most important quicksilver producers in the state"; while the Napa Consolidated mine, also mentioned, is now included with the largest producers (*b*). The occurrence of cinnabar is noted in San Luis Obispo county (*e*), but the mines named, the Oceanic and Polar Star, have ceased to be producers, and no others have replaced them.

The chief mineral resources of Santa Clara county (*f*) are stated to be the cinnabar deposits of New Almaden and Guadalupe, and this still continues to be the case, although the last named has not been an active establishment since 1885. The New Almaden mine is still the largest quicksilver producer in the United States, but its yearly yield is much less than formerly. (*b*)

Santa Barbara county (*g*) is the most southern point where the occurrence of cinnabar is noted, and its single mine, Las Prietas, has long ceased to be active. The Great Eastern is named as the chief mine in Sonoma county (*g*), and it is now the only one in operation there. Reference is made to the Altoona mine, in Trinity county (*g*), now classed with the inactive mines, and that closes the list for California in the Tenth Census.

Douglas county, Oregon (*g*), is credited with the New Idrian mine, which still exists under another name, but was not a producer at the Eleventh Census. In the tables of the present report for the Eleventh Census 2 other mines in the same county are included under the head of "Unproductive mines", but they show fair promise for future production. The occurrence of ore seems to be similar to that of California mines, and it represents the northern end of the series of deposits, the southern extremity of which is in Santa Barbara county, California. "It would be incorrect, however, to characterize the entire series as a 'belt', for toward the north the known occurrences are at long intervals." (*g*) The considerable quantities of float cinnabar mentioned as having been found in Idaho (*h*) are not known to have added to the quicksilver supply, and if there are any quicksilver mines in that state they have not been reported.

Utah is the last on the list, "with several quicksilver claims, the most important of which are the Geyser and Jenny Lind". In 1880 the developments were "very limited, no attempts having been made to reduce the ore" (*i*), and since that date they have made no sign. Mention is also made of cinnabar in Piute county. After the Tenth Census year this claim was worked as the Lucky Boy mine. It is situated about 6 miles south of Marysville, and was idle in 1889. Previously it had produced about 200 flasks of quicksilver. The ore is a selenide of mercury.

In 1889 Colorado and Arizona made claims to recognition as having cinnabar deposits. No quicksilver has been produced within their borders, but specimens of low-grade ores are reported.

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[a] Compare Tenth Census, volume XIII; United States geological survey, volume XIII, and Professor S. B. Christy, American Journal of Science and Arts, volume XVII, June, 1879.

[b] See tables of yearly production, page 188.

[c] Tenth Census report, volume XIII, page 18.

[d] Tenth Census report, volume XIII, pages 19 and 20.

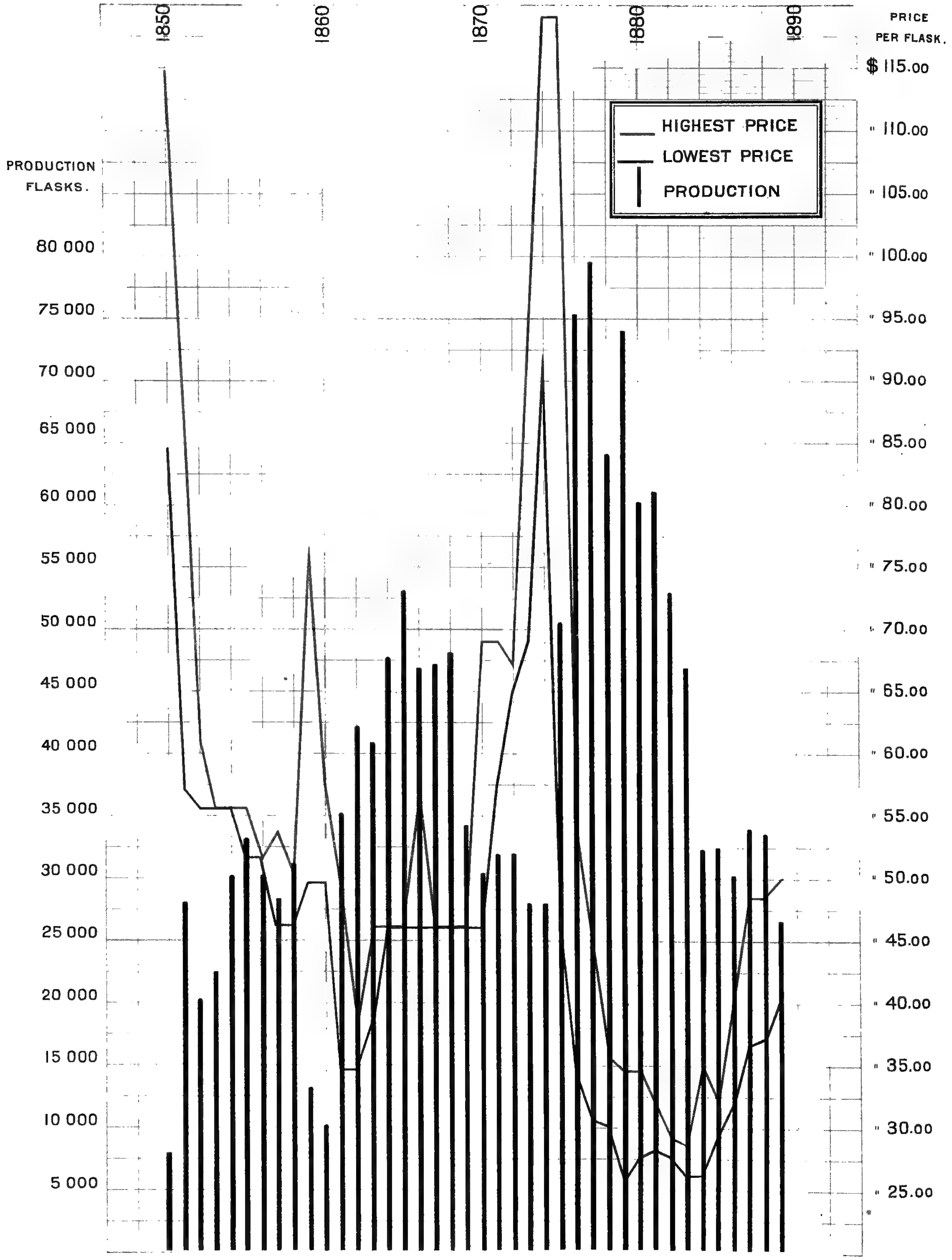
[e] Tenth Census report, volume XIII, page 23.

[f] Tenth Census report, volume XIII, page 24.

[g] Tenth Census report, volume XIII, pages 24, 25, 26, and 27.

[h] Tenth Census report, volume XIII, page 55.

[i] Tenth Census report, volume XIII, pages 455 and 462.


1850
1860
1870
1880
1890
PRICE PER FLASK.
$ 115.00
" 110.00
" 105.00
" 100.00
" 95.00
" 90.00
" 85.00
" 80.00
" 75.00
" 70.00
" 65.00
" 60.00
" 55.00
" 50.00
" 45.00
" 40.00
" 35.00
" 30.00
" 25.00
PRODUCTION FLASKS.
80 000
75 000
70 000
65 000
60 000
55 000
50 000
45 000
40 000
35 000
30 000
25 000
20 000
15 000
10 000
5 000
HIGHEST PRICE
LOWEST PRICE
PRODUCTION

## PRODUCTION OF QUICKSILVER IN THE UNITED STATES, BY DECADES.

In the following table is presented the production of quicksilver in California, which includes the whole production of the United States for the census year 1850 to the calendar year 1890, both inclusive. It is given, in addition to the detailed tables which follow, for the purpose of showing at a glance the rise and decline of the industry.

### QUICKSILVER PRODUCTION IN CALIFORNIA AT PERIODS OF 10 YEARS FROM 1850 TO 1890.

[Flasks.]

| YEARS. | Total. | New Almaden. | New Idria. | Guadalupe. | Redington. | Pope Valley. | Sulphur Bank. | Great Western. | Napa Consolidated. | Great Eastern. | Altoona. | Oakland. | California. | Bradford. | Ætna. | Various mines. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1850 | 7,723 | 7,723 | | | | | | | | | | | | | | |
| 1860 | 10,000 | 7,061 | 1,469 | 1,470 | | | | | | | | | | | | |
| 1870 | 30,077 | 14,423 | 9,888 | | 4,546 | 1,220 | | | | | | | | | | |
| 1880 | 59,926 | 23,465 | 3,209 | 6,670 | 2,139 | 275 | 10,706 | 6,442 | a4,416 | 1,279 | 245 | 166 | 422 | | | b402 |
| 1890 | 22,926 | 12,000 | 977 | | 505 | | 1,608 | 1,334 | 2,498 | 1,046 | | | | 1,290 | 931 | c737 |

a Including Ætna.

b From the Saint John mine.

c Principally from the Manhattan mine.

In the following table the total product of quicksilver for the United States in each year of the industry is associated with its approximate value:

### ANNUAL QUICKSILVER PRODUCT IN THE UNITED STATES, WITH ITS VALUE.

| YEARS. | Yield in California. (Flasks.) | Approximate valuation. | YEARS. | Yield in California. (Flasks.) | Approximate valuation. |
|---|---|---|---|---|---|
| Total 1850-1859 | 242,994 | $13,717,000 | Total 1870-1879 | 491,066 | $24,322,500 |
| 1850 | 7,723 | 768,000 | 1870 | 30,077 | 1,725,500 |
| 1851 | 27,779 | 1,859,000 | 1871 | 31,686 | 1,999,500 |
| 1852 | 20,000 | 1,166,500 | 1872 | 31,621 | 2,086,000 |
| 1853 | 22,284 | 1,235,500 | 1873 | 27,642 | 2,226,500 |
| 1854 | 30,004 | 1,665,500 | 1874 | 27,756 | 2,919,000 |
| 1855 | 33,000 | 1,768,000 | 1875 | 50,250 | 2,721,000 |
| 1856 | 30,000 | 1,549,500 | 1876 | 75,074 | 3,303,000 |
| 1857 | 28,204 | 1,402,000 | 1877 | 79,396 | 3,041,000 |
| 1858 | 31,000 | 1,482,500 | 1878 | 63,880 | 2,101,500 |
| 1859 | 13,000 | 820,500 | 1879 | 73,684 | 2,199,500 |
| Total 1860-1869 | 403,109 | 17,738,000 | Total 1880-1889 | a407,675 | 13,480,500 |
| 1860 | 10,000 | 535,500 | 1880 | 59,926 | 1,860,000 |
| 1861 | 35,000 | 1,473,500 | 1881 | 60,851 | 1,810,000 |
| 1862 | 42,000 | 1,526,500 | 1882 | 52,732 | 1,500,000 |
| 1863 | 40,531 | 1,705,000 | 1883 | 46,725 | 1,275,000 |
| 1864 | 47,489 | 1,761,500 | 1884 | 31,913 | 975,000 |
| 1865 | 53,000 | 2,433,000 | 1885 | 32,073 | 970,000 |
| 1866 | 46,550 | 2,403,000 | 1886 | 29,981 | 1,060,000 |
| 1867 | 47,000 | 2,157,000 | 1887 | a33,760 | 1,425,000 |
| 1868 | 47,728 | 2,191,000 | 1888 | 33,250 | 1,415,000 |
| 1869 | 33,811 | 1,552,000 | 1889 | a26,464 | 1,190,500 |

a 65 flasks in 1887 and 20 flasks in 1889 from Oregon not included.

### RECAPITULATION.

| DECADES. | Flasks. | Value. |
|---|---|---|
| Total | a1,544,844 | $69,258,000 |
| 1850-1859 | 242,994 | 13,717,000 |
| 1860-1869 | 403,109 | 17,738,000 |
| 1870-1879 | 491,066 | 24,322,500 |
| 1880-1889 | a407,675 | 13,480,500 |

a 85 flasks from Oregon not included.

The annual contribution which each mine has made to the total product is given below:

### TOTAL PRODUCT OF CALIFORNIA QUICKSILVER, BY MINES.

[Flasks.]

| YEARS. | Total. | New Almaden. | New Idria. | Redington. | Sulphur Bank. | Guadalupe. | Great Western. | Ætna. | Napa Consolidated. | Great Eastern. | Bradford. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 1,544,929 | 904,359 | 132,214 | 99,264 | 83,475 | 55,910 | 57,063 | 11,557 | 48,847 | 14,944 | 7,093 |
| 1850 | 7,723 | 7,723 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1851 | 27,779 | 27,779 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1852 | 20,000 | 15,901 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1853 | 22,284 | 22,284 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1854 | 30,004 | 30,004 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1855 | 33,000 | 29,142 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1856 | 30,000 | 27,138 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1857 | 28,204 | 28,204 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1858 | 31,000 | 25,761 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1859 | 13,000 | 1,294 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1860 | 10,000 | 7,061 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1861 | 35,000 | 34,429 | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1862 | 42,000 | 39,671 | ... | 444 | ... | ... | ... | ... | ... | ... | ... |
| 1863 | 40,531 | 32,803 | ... | 852 | ... | ... | ... | ... | ... | ... | ... |
| 1864 | 47,489 | 42,489 | ... | 1,914 | ... | ... | ... | ... | ... | ... | ... |
| 1865 | 53,000 | 47,194 | ... | 3,545 | ... | ... | ... | ... | ... | ... | ... |
| 1866 | 46,550 | 35,150 | 6,525 | 2,254 | ... | ... | ... | ... | ... | ... | ... |
| 1867 | 47,000 | 24,461 | 11,493 | 7,862 | ... | ... | ... | ... | ... | ... | ... |
| 1868 | 47,728 | 25,628 | 12,180 | 8,686 | ... | ... | ... | ... | ... | ... | ... |
| 1869 | 33,811 | 16,898 | 10,315 | 5,018 | ... | ... | ... | ... | ... | ... | ... |
| 1870 | 30,077 | 14,423 | 9,888 | 4,546 | ... | ... | ... | ... | ... | ... | ... |
| 1871 | 31,686 | 18,568 | 8,180 | 2,128 | ... | ... | ... | ... | ... | ... | ... |
| 1872 | 31,621 | 18,574 | 8,171 | 3,046 | ... | ... | ... | ... | ... | ... | ... |
| 1873 | 27,642 | 11,042 | 7,735 | 3,294 | ... | ... | 340 | ... | ... | ... | ... |
| 1874 | 27,756 | 9,084 | 6,911 | 6,678 | 573 | ... | 1,122 | ... | ... | ... | ... |
| 1875 | 50,250 | 13,648 | 8,432 | 7,513 | 5,372 | 3,342 | 3,384 | ... | ... | 412 | ... |
| 1876 | 75,074 | 20,549 | 7,272 | 9,183 | 8,367 | 7,381 | 4,322 | ... | 573 | 387 | ... |
| 1877 | 79,396 | 23,996 | 6,316 | 9,399 | 10,993 | 6,241 | 5,856 | ... | 2,229 | 505 | ... |
| 1878 | 63,880 | 15,852 | 5,138 | 6,686 | 9,465 | 9,072 | 4,963 | ... | 3,049 | 1,366 | ... |
| 1879 | 73,684 | 20,514 | 4,425 | 4,516 | 9,249 | 15,540 | 6,333 | ... | 3,605 | 1,455 | ... |
| 1880 | 59,926 | 23,465 | 3,209 | 2,139 | 10,706 | 6,670 | 6,442 | ... | *a*4,416 | 1,279 | ... |
| 1881 | 60,851 | 26,060 | 2,775 | 2,194 | 11,152 | 5,228 | 6,241 | ... | *a*5,552 | 1,065 | ... |
| 1882 | 52,732 | 28,070 | 1,953 | 2,171 | 5,014 | 1,138 | 5,179 | ... | *a*6,842 | 2,124 | ... |
| 1883 | 46,725 | 29,000 | 1,606 | 1,894 | 2,612 | 84 | 3,869 | ... | *a*5,890 | 1,669 | ... |
| 1884 | 31,913 | 20,000 | 1,025 | 881 | 890 | 1,179 | 3,292 | 2,931 | 1,376 | 332 | ... |
| 1885 | 32,073 | 21,400 | 3,469 | 385 | 1,296 | 35 | 1,144 | 1,309 | 2,197 | 446 | ... |
| 1886 | 29,981 | 18,000 | 1,406 | 409 | 1,449 | ... | 1,949 | 3,478 | 1,769 | 735 | ... |
| 1887 | 33,825 | 20,000 | 1,490 | 689 | 1,890 | ... | 1,446 | 2,880 | 2,694 | 673 | 1,371 |
| 1888 | 33,250 | 18,000 | 1,320 | 126 | 2,164 | ... | 625 | 959 | 4,065 | 1,151 | 3,848 |
| 1889 | 26,484 | 13,100 | 980 | 812 | 2,283 | ... | 556 | ... | 4,590 | 1,345 | 1,874 |

*a* Including Ætna.

### TOTAL PRODUCT OF CALIFORNIA QUICKSILVER, BY MINES—Continued.

[Flasks.]

| YEARS. | Pope Valley. | Saint John. | Altoona. | Oceanic. | Oakland. | California. | Sunderland. | Cloverdale. | Abbott. | Manhattan. | Various mines. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 18,097 | 8,598 | 7,527 | 7,391 | 6,831 | 5,653 | 2,777 | 2,661 | 2,272 | 1,415 | 66,981 |
| 1850 | | | | | | | | | | | |
| 1851 | | | | | | | | | | | |
| 1852 | | | | | | | | | | | 4,099 |
| 1853 | | | | | | | | | | | |
| 1854 | | | | | | | | | | | |
| 1855 | | | | | | | | | | | 3,858 |
| 1856 | | | | | | | | | | | 2,862 |
| 1857 | | | | | | | | | | | |
| 1858 | | | | | | | | | | | 5,239 |
| 1859 | | | | | | | | | | | 11,706 |
| 1860 | | | | | | | | | | | 2,939 |
| 1861 | | | | | | | | | | | 571 |
| 1862 | | | | | | | | | | | 1,885 |
| 1863 | | | | | | | | | | | 6,876 |
| 1864 | 800 | | | | | | | | | | 2,286 |
| 1865 | | | | | | | | | | | 2,261 |
| 1866 | | | | | | | | | | | 2,621 |
| 1867 | | | | | | | | | | | 3,184 |
| 1868 | 1,122 | | | | | | | | | | 112 |
| 1869 | 1,580 | | | | | | | | | | |
| 1870 | 1,220 | | | | | | | | | | |
| 1871 | 1,970 | | | | | | | | | | 840 |
| 1872 | 1,830 | | | | | | | | | | |
| 1873 | 1,955 | | | | | | | | | | 3,276 |
| 1874 | 1,645 | 1,743 | | | | | | | | | |
| 1875 | 1,940 | 1,927 | 533 | | | | | | | | 3,747 |
| 1876 | 300 | 1,683 | 1,979 | 2,358 | 2,150 | 965 | 1,570 | 1,028 | 1,436 | 976 | 2,595 |
| 1877 | 1,060 | 1,463 | 1,317 | 2,575 | 1,395 | 1,516 | 735 | 1,291 | 836 | 439 | 1,234 |
| 1878 | 1,075 | | 1,534 | 1,679 | 1,615 | 1,640 | 472 | 116 | | | 158 |
| 1879 | 1,325 | 1,290 | 1,919 | 779 | 1,505 | 1,110 | | 18 | | | 101 |
| 1880 | 275 | 492 | 245 | | 166 | 422 | | | | | |
| 1881 | | | | | | | | 208 | | | 376 |
| 1882 | | | | | | | | | | | 241 |
| 1883 | | | | | | | | | | | 101 |
| 1884 | | | | | | | | | | | 7 |
| 1885 | | | | | | | | | | | 392 |
| 1886 | | | | | | | | | | | 786 |
| 1887 | | | | | | | | | | | *a*692 |
| 1888 | | | | | | | | | | | 992 |
| 1889 | | | | | | | | | | | *b*944 |

*a* Including 65 flasks from Oregon.

*b* Including 20 flasks from Oregon.

It is possible also from the existing records to present the statistics of production for every mine in each month for the last 10 years, as follows:

### PRODUCTION OF QUICKSILVER IN CALIFORNIA FROM 1880 TO 1889, BY MONTHS.

[Flasks.]

### 1880.

| MONTHS. | Total. | New Almaden. | New Idria. | Redington. | Sulphur Bank. | Guadalupe. | Great Western. | Ætna. (*a*) | Napa. (*a*) | Great Eastern. | Bradford. | Various mines. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 59,926 | 23,465 | 3,209 | 2,139 | 10,706 | 6,670 | 6,442 | | 4,416 | 1,279 | | 1,600 |
| January | 4,670 | 1,539 | 203 | 142 | 760 | 1,000 | 550 | | 205 | 39 | | 232 |
| February | 4,895 | 1,809 | 96 | 310 | 965 | 535 | 565 | | 375 | 110 | | 130 |
| March | 5,977 | 2,155 | 443 | 239 | 1,286 | 730 | 565 | | 251 | 210 | | 98 |
| April | 4,261 | 1,667 | 165 | 103 | 611 | 645 | 574 | | 161 | 96 | | 239 |
| May | 5,351 | 1,938 | 226 | 356 | 1,130 | 560 | 572 | | 315 | 164 | | 90 |
| June | 5,283 | 1,985 | 269 | 127 | 819 | 550 | 585 | | 420 | 142 | | 386 |
| July | 4,189 | 1,688 | 250 | 135 | 933 | | 540 | | 455 | 118 | | 70 |
| August | 5,260 | 2,360 | 312 | 189 | 878 | 340 | 525 | | 455 | 133 | | 68 |
| September | 4,708 | 2,166 | 245 | 175 | 687 | 300 | 452 | | 480 | 122 | | 81 |
| October | 5,275 | 1,858 | 216 | 166 | 865 | 1,100 | 557 | | 358 | 57 | | 98 |
| November | 5,748 | 2,238 | 539 | 96 | 1,209 | 500 | 467 | | 591 | 42 | | 66 |
| December | 4,309 | 2,062 | 245 | 101 | 563 | 410 | 490 | | 350 | 46 | | 42 |

*a* Production of Ætna and Napa mines from 1880 to 1883 under heading of Napa mine.

PRODUCTION OF QUICKSILVER IN CALIFORNIA FROM 1880 TO 1889, BY MONTHS—Continued.

[Flasks.]

### 1881.

| MONTHS. | Total. | New Almaden. | New Idria. | Redington. | Sulphur Bank. | Guadalupe. | Great Western. | Ætna. (*a*) | Napa. (*a*) | Great Eastern. | Bradford. | Various mines. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 60, 851 | 26, 060 | 2, 775 | 2, 194 | 11, 152 | 5, 228 | 6, 241 | ........ | 5, 552 | 1, 065 | ........ | 584 |
| January | 5, 861 | 2, 259 | 330 | 140 | 895 | 1, 300 | 451 | ........ | 430 | 13 | ........ | 43 |
| February | 4, 261 | 2, 187 | 171 | 32 | 635 | 600 | 399 | ........ | 233 | ........ | ........ | 4 |
| March | 5, 560 | 2, 466 | 206 | 354 | 1, 100 | 350 | 400 | ........ | 505 | 179 | ........ | ........ |
| April | 5, 071 | 2, 507 | 158 | 284 | 706 | 357 | 447 | ........ | 466 | 123 | ........ | 23 |
| May | 4, 889 | 1, 346 | 200 | 218 | 1, 163 | 500 | 681 | ........ | 659 | 97 | ........ | 25 |
| June | 5, 564 | 1, 780 | 201 | 196 | 1, 463 | 340 | 801 | ........ | 621 | 94 | ........ | 68 |
| July | 5, 188 | 2, 208 | 110 | 160 | 1, 057 | 255 | 714 | ........ | 481 | 47 | ........ | 156 |
| August | 5, 350 | 2, 260 | 209 | 190 | 1, 139 | 300 | 585 | ........ | 490 | 57 | ........ | 120 |
| September | 4, 965 | 2, 090 | 212 | 187 | 1, 076 | 201 | 457 | ........ | 592 | 113 | ........ | 37 |
| October | 4, 965 | 2, 223 | 140 | 165 | 969 | 400 | 414 | ........ | 485 | 106 | ........ | 63 |
| November | 5, 232 | 2, 572 | 577 | 180 | 588 | 375 | 434 | ........ | 310 | 166 | ........ | 30 |
| December | 3, 945 | 2, 162 | 261 | 88 | 361 | 250 | 458 | ........ | 280 | 70 | ........ | 15 |

### 1882.

| MONTHS. | Total. | New Almaden. | New Idria. | Redington. | Sulphur Bank. | Guadalupe. | Great Western. | Ætna. (*a*) | Napa. (*a*) | Great Eastern. | Bradford. | Various mines. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 52, 732 | 28, 070 | 1, 953 | 2, 171 | 5, 014 | 1, 138 | 5, 179 | ........ | 6, 842 | 2, 124 | ........ | 241 |
| January | 3, 664 | 1, 632 | 179 | 178 | 623 | 50 | 395 | ........ | 430 | 144 | ........ | 33 |
| February | 3, 767 | 1, 924 | 121 | 145 | 460 | 210 | 348 | ........ | 440 | 98 | ........ | 21 |
| March | 3, 946 | 2, 078 | 160 | 70 | 359 | 200 | 505 | ........ | 459 | 91 | ........ | 24 |
| April | 4, 027 | 2, 110 | 127 | 174 | 319 | 229 | 486 | ........ | 525 | 57 | ........ | ........ |
| May | 4, 611 | 2, 446 | 269 | 211 | 354 | 13 | 521 | ........ | 737 | 55 | ........ | 5 |
| June | 4, 167 | 2, 318 | 121 | 131 | 522 | 30 | 456 | ........ | 485 | 76 | ........ | 28 |
| July | 4, 381 | 2, 522 | 169 | 195 | 579 | ........ | 410 | ........ | 380 | 111 | ........ | 15 |
| August | 4, 685 | 2, 432 | 130 | 184 | 418 | 50 | 490 | ........ | 582 | 388 | ........ | 11 |
| September | 5, 209 | 2, 766 | 129 | 225 | 430 | 140 | 513 | ........ | 641 | 348 | ........ | 17 |
| October | 5, 129 | 2, 844 | 266 | 251 | 370 | 60 | 516 | ........ | 580 | 229 | ........ | 13 |
| November | 4, 511 | 2, 619 | 156 | 96 | 280 | 81 | 200 | ........ | 718 | 306 | ........ | 55 |
| December | 4, 635 | 2, 379 | 126 | 311 | 300 | 75 | 339 | ........ | 865 | 221 | ........ | 19 |

### 1883.

| MONTHS. | Total. | New Almaden. | New Idria. | Redington. | Sulphur Bank. | Guadalupe. | Great Western. | Ætna. (*a*) | Napa. (*a*) | Great Eastern. | Bradford. | Various mines. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 46, 725 | 29, 000 | 1, 606 | 1, 894 | 2, 612 | 84 | 3, 869 | ........ | 5, 890 | 1, 669 | ........ | 101 |
| January | 4, 582 | 2, 497 | 112 | 367 | 280 | 77 | 390 | ........ | 590 | 262 | ........ | 7 |
| February | 3, 600 | 2, 150 | 133 | 181 | 310 | 7 | 364 | ........ | 295 | 156 | ........ | 4 |
| March | 3, 875 | 2, 230 | 142 | 202 | 335 | ........ | 305 | ........ | 485 | 162 | ........ | 14 |
| April | 3, 354 | 1, 756 | 76 | 243 | 310 | ........ | 294 | ........ | 530 | 142 | ........ | 3 |
| May | 3, 768 | 2, 344 | 144 | 135 | 350 | ........ | 293 | ........ | 325 | 164 | ........ | 13 |
| June | 3, 561 | 2, 214 | 137 | 165 | 91 | ........ | 400 | ........ | 360 | 184 | ........ | 10 |
| July | 4, 024 | 2, 618 | 85 | 141 | 130 | ........ | 446 | ........ | 452 | 150 | ........ | 2 |
| August | 4, 431 | 3, 000 | 139 | 94 | 112 | ........ | 315 | ........ | 695 | 76 | ........ | ........ |
| September | 4, 642 | 3, 010 | 164 | 45 | 265 | ........ | 297 | ........ | 750 | 81 | ........ | 30 |
| October | 4, 129 | 2, 672 | 272 | 109 | 206 | ........ | 215 | ........ | 521 | 134 | ........ | ........ |
| November | 3, 488 | 2, 212 | 115 | 78 | 160 | ........ | 208 | ........ | 613 | 102 | ........ | ........ |
| December | 3, 271 | 2, 297 | 87 | 134 | 63 | ........ | 342 | ........ | 274 | 56 | ........ | 18 |

### 1884.

| MONTHS. | Total. | New Almaden. | New Idria. | Redington. | Sulphur Bank. | Guadalupe. | Great Western. | Ætna. (*a*) | Napa. (*a*) | Great Eastern. | Bradford. | Various mines. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 31, 913 | 20, 000 | 1, 025 | 881 | 890 | 1, 179 | 3, 292 | 2, 931 | 1, 376 | 332 | ........ | 7 |
| January | 2, 805 | 1, 440 | 103 | 127 | 263 | ........ | 373 | 329 | 135 | 28 | ........ | 7 |
| February | 2, 321 | 1, 458 | 59 | 104 | ........ | ........ | 241 | 276 | 174 | 9 | ........ | ........ |
| March | 2, 459 | 1, 606 | 36 | 123 | 68 | ........ | 223 | 249 | 152 | 2 | ........ | ........ |
| April | 2, 709 | 1, 785 | 75 | 50 | 76 | ........ | 232 | 422 | 69 | ........ | ........ | ........ |
| May | 2, 470 | 1, 672 | 125 | 53 | 200 | ........ | 169 | 245 | 6 | ........ | ........ | ........ |
| June | 2, 694 | 1, 859 | 44 | 118 | ........ | 200 | 258 | 215 | ........ | ........ | ........ | ........ |
| July | 2, 628 | 1, 543 | 29 | 71 | 52 | 200 | 258 | 374 | 101 | ........ | ........ | ........ |
| August | 2, 912 | 1, 804 | 63 | 47 | 20 | 306 | 334 | 228 | 110 | ........ | ........ | ........ |
| September | 2, 377 | 1, 448 | 67 | 52 | 35 | 58 | 354 | 136 | 169 | 58 | ........ | ........ |
| October | 2, 668 | 1, 625 | 115 | 68 | 25 | 160 | 328 | 153 | 90 | 104 | ........ | ........ |
| November | 2, 985 | 1, 900 | 157 | 32 | 53 | 150 | 230 | 132 | 240 | 91 | ........ | ........ |
| December | 2, 885 | 1, 860 | 152 | 36 | 98 | 105 | 292 | 172 | 130 | 40 | ........ | ........ |

*a* Production of Ætna and Napa mines from 1880 to 1883 under heading of Napa mine.

PRODUCTION OF QUICKSILVER IN CALIFORNIA FROM 1880 TO 1889, BY MONTHS—Continued.

[Flasks.]

### 1885.

| MONTHS. | Total. | New Almaden. | New Idria. | Redington. | Sulphur Bank. | Guadalupe. | Great Western. | Ætna. | Napa. | Great Eastern. | Bradford. | Various mines. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 32,073 | 21,400 | 3,469 | 385 | 1,296 | 35 | 1,144 | 1,309 | 2,197 | 446 | ... | 392 |
| January | 2,483 | 1,700 | 172 | 40 | 24 | ... | 190 | 189 | 131 | 37 | ... | ... |
| February | 2,316 | 1,506 | 245 | 24 | 85 | 35 | 70 | 96 | 180 | 75 | ... | ... |
| March | 2,262 | 1,500 | 314 | ... | 83 | ... | 80 | 88 | 145 | 33 | ... | 19 |
| April | 2,816 | 2,003 | 340 | ... | 69 | ... | 80 | 142 | 145 | 37 | ... | ... |
| May | 2,793 | 2,000 | 269 | ... | 194 | ... | 75 | 62 | 190 | ... | ... | 3 |
| June | 2,713 | 1,750 | 330 | 50 | 91 | ... | 62 | 112 | 250 | 63 | ... | 5 |
| July | 2,694 | 1,750 | 321 | 43 | 209 | ... | 75 | 45 | 191 | 50 | ... | 10 |
| August | 3,047 | 2,104 | 324 | 49 | 150 | ... | 80 | 118 | 175 | ... | ... | 47 |
| September | 2,978 | 1,936 | 347 | 57 | 85 | ... | 95 | 201 | 180 | ... | ... | 77 |
| October | 2,468 | 1,598 | 236 | 42 | 123 | ... | 85 | 52 | 185 | 65 | ... | 82 |
| November | 2,468 | 1,576 | 292 | 43 | 61 | ... | 122 | 54 | 190 | 43 | ... | 87 |
| December | 3,035 | 1,977 | 279 | 37 | 122 | ... | 130 | 150 | 235 | 43 | ... | 62 |

### 1886.

| MONTHS. | Total. | New Almaden. | New Idria. | Redington. | Sulphur Bank. | Guadalupe. | Great Western. | Ætna. | Napa. | Great Eastern. | Bradford. | Various mines. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 29,981 | 18,000 | 1,406 | 409 | 1,449 | ... | 1,949 | 3,478 | 1,769 | 735 | ... | 786 |
| January | 2,398 | 1,431 | 70 | 42 | 100 | ... | 339 | 162 | 147 | 73 | ... | 34 |
| February | 2,103 | 1,100 | 175 | 24 | 168 | ... | 274 | 132 | 192 | 53 | ... | 45 |
| March | 2,425 | 1,522 | 20 | 21 | 91 | ... | 226 | 209 | 218 | 43 | ... | 75 |
| April | 2,293 | 1,256 | 90 | 36 | 172 | ... | 115 | 328 | 172 | 62 | ... | 62 |
| May | 2,381 | 1,600 | 101 | 18 | 36 | ... | 99 | 228 | 128 | 76 | ... | 95 |
| June | 2,722 | 1,806 | 110 | 19 | 113 | ... | 126 | 276 | 123 | 71 | ... | 78 |
| July | 2,601 | 1,572 | 95 | 24 | 98 | ... | 138 | 345 | 138 | 64 | ... | 127 |
| August | 2,202 | 1,240 | 105 | 35 | 119 | ... | 156 | 313 | 74 | 76 | ... | 84 |
| September | 2,108 | 1,210 | 179 | 30 | 100 | ... | 107 | 303 | 82 | 64 | ... | 33 |
| October | 2,390 | 1,280 | 106 | 50 | 150 | ... | 171 | 392 | 124 | 65 | ... | 52 |
| November | 3,232 | 1,900 | 180 | 76 | 191 | ... | 109 | 477 | 209 | 55 | ... | 35 |
| December | 3,126 | 2,083 | 175 | 34 | 171 | ... | 89 | 313 | 162 | 33 | ... | 66 |

### 1887.

| MONTHS. | Total. | New Almaden. | New Idria. | Redington. | Sulphur Bank. | Guadalupe. | Great Western. | Ætna. | Napa. | Great Eastern. | Bradford. | Various mines. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 33,760 | 20,000 | 1,490 | 689 | 1,890 | ... | 1,446 | 2,880 | 2,694 | 673 | 1,371 | 627 |
| January | 3,077 | 1,904 | 185 | 51 | 162 | ... | 56 | 450 | 181 | 76 | ... | 12 |
| February | 2,408 | 1,700 | 40 | ... | 149 | ... | 86 | 240 | 150 | 43 | ... | ... |
| March | 2,556 | 1,584 | 95 | 74 | 110 | ... | 105 | 125 | 275 | 48 | ... | 140 |
| April | 2,586 | 1,671 | 105 | 91 | 157 | ... | 90 | 200 | 212 | 29 | ... | 31 |
| May | 2,830 | 2,040 | 50 | 80 | 126 | ... | 152 | 100 | 215 | 27 | ... | 40 |
| June | 2,822 | 1,700 | 170 | 82 | 127 | ... | 126 | 200 | 220 | 93 | ... | 104 |
| July | 2,820 | 1,567 | 125 | 56 | 175 | ... | 194 | 200 | 205 | 57 | 201 | 40 |
| August | 2,781 | 1,517 | 90 | 72 | 160 | ... | 108 | 200 | 275 | 61 | 220 | 78 |
| September | 2,923 | 1,535 | 120 | 26 | 297 | ... | 123 | 400 | 160 | 42 | 195 | 25 |
| October | 2,859 | 1,405 | 140 | 66 | 171 | ... | 132 | 300 | 304 | 64 | 228 | 49 |
| November | 2,613 | 1,225 | 214 | 82 | 113 | ... | 127 | 165 | 247 | 71 | 295 | 74 |
| December | 3,485 | 2,152 | 156 | 9 | 143 | ... | 147 | 300 | 250 | 62 | 232 | 34 |

### 1888.

| MONTHS. | Total. | New Almaden. | New Idria. | Redington. | Sulphur Bank. | Guadalupe. | Great Western. | Ætna. | Napa. | Great Eastern. | Bradford. | Various mines. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 33,250 | 18,000 | 1,320 | 126 | 2,164 | ... | 625 | 959 | 4,065 | 1,151 | 3,848 | 992 |
| January | 3,949 | 2,650 | 118 | ... | 292 | ... | 61 | 246 | 235 | 84 | 179 | 84 |
| February | 2,733 | 1,730 | 82 | ... | 156 | ... | 64 | 105 | 223 | 79 | 243 | 51 |
| March | 2,481 | 1,400 | 90 | ... | 150 | ... | 43 | 95 | 288 | 108 | 270 | 37 |
| April | 2,862 | 1,579 | 110 | ... | 138 | ... | 95 | 143 | 324 | 153 | 292 | 28 |
| May | 3,037 | 1,610 | 125 | ... | 155 | ... | 69 | 226 | 320 | 80 | 357 | 95 |
| June | 2,956 | 1,500 | 120 | ... | 189 | ... | 26 | 94 | 345 | 110 | 454 | 118 |
| July | 2,359 | 1,100 | 120 | ... | 167 | ... | 34 | 50 | 248 | 94 | 463 | 83 |
| August | 2,547 | 1,109 | 110 | ... | 215 | ... | 29 | ... | 347 | 93 | 527 | 117 |
| September | 2,348 | 1,178 | 60 | ... | 195 | ... | 42 | ... | 370 | 58 | 357 | 88 |
| October | 2,635 | 1,269 | 185 | 36 | 180 | ... | 47 | ... | 440 | 88 | 294 | 96 |
| November | 2,604 | 1,400 | 90 | 30 | 176 | ... | 28 | ... | 475 | 82 | 220 | 103 |
| December | 2,739 | 1,475 | 110 | 60 | 151 | ... | 87 | ... | 450 | 122 | 192 | 92 |

### PRODUCTION OF QUICKSILVER IN CALIFORNIA FROM 1880 TO 1889, BY MONTHS—Continued.

[Flasks.]

### 1889.

| MONTHS. | Total. | New Almaden. | New Idria. | Redington. | Sulphur Bank. | Guadalupe. | Great Western. | Ætna. | Napa. | Great Eastern. | Bradford. | Various mines. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 26, 464 | 13, 100 | 980 | 812 | 2, 283 | ............ | 556 | ............ | 4, 590 | 1, 345 | 1, 874 | 924 |
| January | 2, 337 | 1, 200 | 65 | ............ | 173 | ............ | 81 | ............ | 385 | 94 | 230 | 109 |
| February | 1, 813 | 820 | 65 | ............ | 173 | ............ | 45 | ............ | 400 | 76 | 182 | 52 |
| March | 2, 217 | 1, 290 | 70 | ............ | 175 | ............ | 34 | ............ | 380 | 89 | 116 | 63 |
| April | 2, 203 | 1, 249 | 70 | ............ | 215 | ............ | 30 | ............ | 320 | 92 | 119 | 108 |
| May | 2, 085 | 870 | 70 | 206 | 192 | ............ | ............ | ............ | 445 | 97 | 132 | 73 |
| June | 2, 218 | 950 | 75 | 117 | 235 | ............ | ............ | ............ | 415 | 211 | 152 | 63 |
| July | 2, 066 | 966 | 70 | 124 | 211 | ............ | 41 | ............ | 340 | 135 | 110 | 69 |
| August | 2, 223 | 1, 000 | 70 | 64 | 216 | ............ | 17 | ............ | 450 | 168 | 170 | 68 |
| September | 2, 073 | 970 | 75 | 73 | 224 | ............ | 97 | ............ | 360 | 77 | 136 | 61 |
| October | 2, 453 | 1, 300 | 80 | 89 | 164 | ............ | 70 | ............ | 385 | 87 | 214 | 64 |
| November | 2, 492 | 1, 300 | 130 | 139 | 150 | ............ | 80 | ............ | 380 | 107 | 134 | 72 |
| December | 2, 284 | 1, 185 | 140 | ............ | 155 | ............ | 61 | ............ | 330 | 112 | 179 | 122 |

In collecting the data for the world's production of quicksilver every effort was made to obtain some reliable statistics of the production of quicksilver in Mexico and China, but without success at the time of making this report.

### THE WORLD'S PRODUCTION OF QUICKSILVER FOR 10 YEARS. (*a*)

| YEARS. | Total supply. | California. | SPAIN. |  | AUSTRIA-HUNGARY. |  | Italy. | Russia. | Estimated consumption. | Estimated stock in London, England. |
|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  | Almaden. | Various. (*b*) | Idria. | Various. (*c*) |  |  |  |  |
| Total | 1, 146, 741 | *d*407, 675 | 485, 939 | 16, 273 | 135, 403 | 8, 808 | *e*75, 704 | 16, 939 | 1, 142, 890 | ............ |
| 1880 | 122, 536 | 59, 926 | 45, 322 | (*f*) | 12, 356 | 712 | 4, 220 | ............ | 95, 600 | 68, 500 |
| 1881 | 122, 678 | 60, 851 | 44, 989 | (*f*) | 11, 333 | 720 | 4, 785 | ............ | 106, 300 | 84, 899 |
| 1882 | 119, 394 | 52, 732 | 46, 716 | 2, 795 | 11, 663 | 588 | 4, 900 | ............ | 116, 200 | 88, 000 |
| 1883 | 118, 858 | 46, 725 | 49, 177 | 2, 165 | 13, 152 | 709 | 6, 930 | ............ | 124, 800 | 82, 014 |
| 1884 | 105, 430 | 31, 913 | 48, 098 | 2, 219 | 13, 967 | 733 | 8, 500 | ............ | 111, 300 | 76, 105 |
| 1885 | 101, 748 | 32, 073 | 45, 813 | 2, 046 | 13, 503 | 773 | 7, 540 | ............ | 108, 300 | 69, 467 |
| 1886 | 107, 588 | 29, 981 | 51, 199 | 2, 277 | 14, 496 | 1, 400 | 8, 235 | ............ | 123, 050 | 54, 000 |
| 1887 | 116, 711 | 33, 760 | 53, 276 | 2, 894 | 14. 676 | 1, 030 | 9, 220 | 1, 855 | 131, 700 | 39, 000 |
| 1888 | 117, 956 | 33, 250 | 51, 872 | 1, 877 | 14, 962 | 1, 018 | 10, 200 | 4, 777 | 109, 900 | 47, 000 |
| 1889 | 113, 842 | 26, 464 | 49, 477 | (*f*) | 15, 295 | *g*1, 125 | 11, 174 | 10, 307 | 115, 740 | 45, 100 |

*a* In the United States the flask contains 76.5 pounds avoirdupois, or 34.7 kilograms; in Spain, Austria-Hungary, Italy, Russia, and elsewhere, only 34.5 kilograms.

*b* Comprises mines in the provinces of Oviedo, Granada, and Cuidad Real.

*c* Comprises mines in Carniola and Hungary.

*d* In 1887 Oregon produced 65 flasks and in 1889 20 flasks, which are not included in this total.

*e* Figures taken from monograph on the quicksilver mines of Monte Amiata, by Mr. P. de Ferrari, M. E., 1889.

*f* Quantities unknown.

*g* Comprises mines in Carniola only, the production of Hungary not being known.

The following table is published simply to show the various statistics which have appeared as to the production of quicksilver in Italy:

### VARIOUS STATEMENTS AS TO THE PRODUCTION OF QUICKSILVER IN ITALY.

[Flasks.]

| YEARS. | PRODUCTION. | | |
|---|---|---|---|
| | Letter from Rome. (*a*) | De Ferrari's table. (*b*) | De Ferrari's table. (*c*) |
| Total | 67, 726. 9 | 66, 689. 4 | 75, 704 |
| 1880 | 3, 314. 3 | 3, 343. 1 | 4, 220 |
| 1881 | 4, 755. 3 | 3, 689. 0 | 4, 785 |
| 1882 | 4, 034. 8 | 4, 034. 8 | 4, 900 |
| 1883 | 5, 936. 9 | 5, 936. 9 | 6, 930 |
| 1884 | 7, 694. 9 | 7, 694. 9 | 8, 500 |
| 1885 | 6, 830. 3 | 6, 830. 3 | 7, 540 |
| 1886 | 7, 233. 8 | 7, 233. 8 | 8, 235 |
| 1887 | 7, 032. 1 | 7, 032. 1 | 9, 220 |
| 1888 | 9, 770. 0 | 9, 770. 0 | 10, 200 |
| 1889 | 11, 124. 5 | 11, 124. 5 | 11, 174 |

*a* Letter from D'Amiani, under secretary of state of his majesty's foreign affairs at Rome, dated August 8, 1890.
*b* From table, page 145, of P. de Ferrari's monograph "Le miniere di mercurio del Monte Amiata".
*c* From table, page 146, of same, giving production of Monte Amiata in flasks.

### PRICES PER FLASK OBTAINED IN NEW YORK FOR CALIFORNIA QUICKSILVER IN 1889.

| MONTHS. | Prices obtained in New York. | Netting in San Francisco, freight and drayage $1.30. | Rothschild's quotation and equivalent for quicksilver laid down in New York, duty added. | | | | Laid down in New York, duty added. | London outsiders' price. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | £ | *s.* | *d.* | | | £ | *s.* | *d.* |
| January— | | | | | | | | | | |
| Highest | $44. 00 | $42. 70 | 9 | 10 | 0 | $50. 50 | $46. 60 | 8 | 15 | 0 |
| Lowest | 43. 00 | 41. 70 | 9 | 10 | 0 | 50. 50 | 43. 55 | 8 | 3 | 6 |
| February— | | | | | | | | | | |
| Highest | 43. 25 | 41. 95 | 8 | 10 | 0 | 45. 25 | 43. 40 | 8 | 3 | 0 |
| Lowest | 40. 00 | 38. 70 | 7 | 10 | 0 | 40. 00 | 39. 30 | 7 | 7 | 6 |
| March— | | | | | | | | | | |
| Highest | 40. 50 | 39. 20 | 7 | 15 | 0 | 41. 25 | 41. 40 | 7 | 15 | 6 |
| Lowest | 39. 00 | 37. 70 | 7 | 10 | 0 | 40. 00 | 39. 30 | 7 | 7 | 6 |
| April— | | | | | | | | | | |
| Highest | 42. 00 | 40. 70 | 8 | 0 | 0 | 42. 60 | 42. 60 | 8 | 0 | 0 |
| Lowest | 40. 00 | 38. 70 | 7 | 12 | 6 | 40. 60 | 40. 60 | 7 | 12 | 6 |
| May— | | | | | | | | | | |
| Highest | 45. 25 | 43. 95 | 8 | 10 | 0 | 45. 25 | 44. 35 | 8 | 6 | 6 |
| Lowest | 42. 75 | 41. 45 | 8 | 5 | 0 | 44. 00 | 41. 85 | 7 | 17 | 0 |
| June— | | | | | | | | | | |
| Highest | 48. 00 | 46. 70 | 9 | 10 | 0 | 50. 50 | 47. 70 | 8 | 19 | 0 |
| Lowest | 48. 00 | 46. 70 | 8 | 15 | 0 | 46. 60 | 43. 55 | 8 | 3 | 6 |
| July— | | | | | | | | | | |
| Highest | 49. 00 | 47. 70 | 9 | 15 | 0 | 51. 75 | 50. 20 | 9 | 8 | 6 |
| Lowest | 46. 00 | 44. 70 | 9 | 10 | 0 | 50. 50 | 46. 60 | 8 | 15 | 0 |
| August— | | | | | | | | | | |
| Highest | 49. 00 | 47. 70 | 9 | 15 | 0 | 51. 75 | 49. 95 | 9 | 7 | 6 |
| Lowest | 48. 00 | 46. 70 | 9 | 15 | 0 | 51. 75 | 48. 90 | 9 | 3 | 6 |
| September— | | | | | | | | | | |
| Highest | 49. 50 | 48. 20 | 9 | 15 | 0 | 51. 75 | 49. 15 | 9 | 4 | 6 |
| Lowest | 48. 50 | 47. 20 | 9 | 15 | 0 | 51. 75 | 48. 75 | 9 | 3 | 0 |
| October— | | | | | | | | | | |
| Highest | 49. 00 | 47. 70 | 9 | 5 | 0 | 49. 30 | 49. 30 | 9 | 5 | 0 |
| Lowest | 48. 50 | 47. 20 | 9 | 5 | 0 | 49. 30 | 47. 30 | 8 | 17 | 6 |
| November— | | | | | | | | | | |
| Highest | 50. 00 | 48. 70 | 9 | 15 | 0 | 51. 75 | 50. 90 | 9 | 11 | 0 |
| Lowest | 49. 00 | 47. 70 | 9 | 10 | 0 | 50. 50 | 49. 95 | 9 | 7 | 6 |
| December— | | | | | | | | | | |
| Highest | 50. 00 | 48. 70 | 9 | 15 | 0 | 51. 75 | 50. 35 | 9 | 9 | 0 |
| Lowest | 48. 50 | 47. 20 | 9 | 15 | 0 | 51. 75 | 49. 30 | 9 | 5 | 0 |

## MONTHLY QUOTATIONS PER FLASK FOR QUICKSILVER AT SAN FRANCISCO FROM 1880 TO 1889, INCLUSIVE.

| MONTHS. | 1880. | | 1881. | | 1882. | | 1883. | | 1884. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. |
| January | $34.45 | $28.30 | $28.30 | $27.90 | $28.50 | $28.30 | $26.75 | $26.00 | $26.25 | $26.00 |
| February | 34.45 | 28.30 | 29.85 | 28.30 | 28.50 | 28.10 | 27.25 | 26.00 | 29.00 | 26.00 |
| March | 34.45 | 29.85 | 29.05 | 27.90 | 28.50 | 28.10 | 28.00 | 26.75 | 29.00 | 28.00 |
| April | 30.60 | 29.85 | 29.85 | 28.70 | 29.05 | 28.50 | 27.00 | 26.75 | 29.00 | 28.00 |
| May | 30.60 | 29.85 | 28.90 | 28.50 | 29.10 | 28.70 | 27.00 | 26.75 | 29.00 | 29.00 |
| June | 30.60 | 27.55 | 28.70 | 28.50 | 28.70 | 28.50 | 28.50 | 26.75 | 29.00 | 29.00 |
| July | 30.60 | 27.90 | 29.05 | 28.50 | 28.50 | 28.30 | 28.50 | 27.50 | 29.00 | 28.75 |
| August | 34.45 | 29.45 | 29.05 | 28.30 | 28.50 | 28.30 | 27.50 | 26.25 | 30.00 | 28.75 |
| September | 30.60 | 30.25 | 28.50 | 28.10 | 28.90 | 28.30 | 26.75 | 26.25 | 31.00 | 30.00 |
| October | 30.25 | 29.45 | 31.75 | 29.05 | 28.90 | 28.30 | 26.50 | 26.50 | 30.50 | 29.00 |
| November | 29.85 | 29.45 | 31.75 | 29.85 | 28.50 | 28.10 | 26.50 | 26.00 | 34.00 | 29.00 |
| December | 29.45 | 27.90 | 28.90 | 27.90 | 27.90 | 27.35 | 26.25 | 26.00 | 35.00 | 32.00 |
| Extreme range | 34.45 | 27.55 | 31.75 | 27.90 | 29.10 | 27.35 | 28.50 | 26.00 | 35.00 | 26.00 |

| MONTHS. | 1885. | | 1886. | | 1887. | | 1888. | | 1889. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. |
| January | $33.00 | $32.50 | $32.50 | $32.00 | $38.75 | $38.50 | $48.00 | $42.00 | $43.00 | $41.50 |
| February | 32.50 | 32.50 | 32.50 | 32.50 | 38.75 | 38.50 | 43.00 | 39.00 | 42.00 | 41.50 |
| March | 32.50 | 31.00 | 33.00 | 32.50 | 38.50 | 37.00 | 40.00 | 38.50 | 41.50 | 40.00 |
| April | 31.00 | 30.00 | 33.00 | 33.00 | 40.00 | 37.50 | 38.50 | 38.00 | 41.50 | 40.00 |
| May | 29.00 | 28.50 | 34.00 | 33.00 | 38.00 | 37.50 | 38.00 | 37.25 | 45.00 | 41.00 |
| June | 30.00 | 29.00 | 36.00 | 34.00 | 39.00 | 38.00 | 38.00 | 37.25 | 50.00 | 46.50 |
| July | 30.00 | 29.75 | 37.00 | 36.00 | 38.00 | 37.50 | 37.50 | 37.00 | 47.50 | 46.00 |
| August | 29.75 | 29.50 | 37.00 | 36.75 | 37.00 | 36.50 | 37.25 | 37.00 | 47.50 | 46.00 |
| September | 30.50 | 29.50 | 37.00 | 36.50 | 38.00 | 36.50 | 43.00 | 37.00 | 47.50 | 47.00 |
| October | 30.50 | 30.00 | 39.00 | 38.75 | 39.00 | 37.00 | 44.00 | 43.00 | 47.00 | 46.50 |
| November | 30.00 | 29.75 | 38.75 | 38.50 | 40.00 | 37.00 | 43.00 | 42.50 | 48.00 | 46.00 |
| December | 32.00 | 30.00 | 38.75 | 38.50 | 48.00 | 45.00 | 43.00 | 41.00 | 47.50 | 47.00 |
| Extreme range | 33.00 | 28.50 | 39.00 | 32.00 | 48.00 | 36.50 | 48.00 | 37.00 | 50.00 | 40.00 |

## HIGHEST AND LOWEST PRICES PER FLASK OF QUICKSILVER DURING THE PAST 40 YEARS IN SAN FRANCISCO AND LONDON.

| YEARS. | SAN FRANCISCO. | | LONDON. | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Highest. | Lowest. | Highest. | | | Lowest. | | |
| | | | £ | s. | d. | £ | s. | d. |
| 1850 | $114.75 | $84.15 | 15 | 0 | 0 | 13 | 2 | 6 |
| 1851 | 76.50 | 57.35 | 13 | 15 | 0 | 12 | 5 | 0 |
| 1852 | 61.20 | 55.45 | 11 | 10 | 0 | 9 | 7 | 6 |
| 1853 | 55.45 | 55.45 | 8 | 15 | 0 | 8 | 2 | 6 |
| 1854 | 55.45 | 55.45 | 7 | 15 | 0 | 7 | 5 | 0 |
| 1855 | 55.45 | 51.65 | 6 | 17 | 6 | 6 | 10 | 0 |
| 1856 | 51.65 | 51.65 | 6 | 10 | 0 | 6 | 10 | 0 |
| 1857 | 53.55 | 45.90 | 6 | 10 | 0 | 6 | 10 | 0 |
| 1858 | 49.75 | 45.90 | 7 | 10 | 0 | 7 | 5 | 0 |
| 1859 | 76.50 | 49.75 | 7 | 5 | 0 | 7 | 0 | 0 |
| 1860 | 57.35 | 49.75 | 7 | 0 | 0 | 7 | 0 | 0 |
| 1861 | 49.75 | 34.45 | 7 | 0 | 0 | 7 | 0 | 0 |
| 1862 | 38.25 | 34.45 | 7 | 0 | 0 | 7 | 0 | 0 |
| 1863 | 45.90 | 38.25 | 7 | 0 | 0 | 7 | 0 | 0 |
| 1864 | 45.90 | 45.90 | 9 | 0 | 0 | 7 | 10 | 0 |
| 1865 | 45.90 | 45.90 | 8 | 0 | 0 | 7 | 17 | 6 |
| 1866 | 57.35 | 45.90 | 8 | 0 | 0 | 6 | 17 | 6 |
| 1867 | 45.90 | 45.90 | 7 | 0 | 0 | 6 | 16 | 0 |
| 1868 | 45.90 | 45.90 | 6 | 17 | 0 | 6 | 16 | 0 |
| 1869 | 45.90 | 45.90 | 6 | 17 | 0 | 6 | 16 | 0 |
| 1870 | 68.85 | 45.90 | 10 | 0 | 0 | 6 | 16 | 0 |
| 1871 | $68.85 | $57.35 | 12 | 0 | 0 | 9 | 0 | 0 |
| 1872 | 66.95 | 65.00 | 13 | 0 | 0 | 10 | 0 | 0 |
| 1873 | 91.80 | 68.85 | 20 | 0 | 0 | 12 | 0 | 0 |
| 1874 | 118.55 | 91.80 | 26 | 0 | 0 | 19 | 0 | 0 |
| 1875 | 118.55 | 49.75 | 24 | 0 | 0 | 9 | 17 | 6 |
| 1876 | 53.55 | 34.45 | 12 | 0 | 0 | 7 | 17 | 6 |
| 1877 | 44.00 | 30.60 | 9 | 10 | 0 | 7 | 2 | 6 |
| 1878 | 35.95 | 29.85 | 7 | 5 | 0 | 6 | 7 | 6 |
| 1879 | 34.45 | 25.25 | 8 | 15 | 0 | 5 | 17 | 6 |
| 1880 | 34.45 | 27.55 | 7 | 15 | 0 | 6 | 7 | 6 |
| 1881 | 31.75 | 27.90 | 7 | 0 | 0 | 6 | 2 | 6 |
| 1882 | 29.10 | 27.35 | 6 | 5 | 0 | 5 | 15 | 0 |
| 1883 | 28.50 | 26.00 | 5 | 17 | 6 | 5 | 5 | 0 |
| 1884 | 35.00 | 26.00 | 6 | 15 | 0 | 5 | 2 | 6 |
| 1885 | 33.00 | 28.50 | 6 | 15 | 0 | 5 | 2 | 6 |
| 1886 | 39.00 | 32.00 | 7 | 10 | 0 | 5 | 16 | 3 |
| 1887 | 48.00 | 36.50 | 11 | 5 | 0 | 6 | 7 | 6 |
| 1888 | 48.00 | 37.00 | 10 | 0 | 0 | 7 | 0 | 0 |
| 1889 | 50.00 | 40.00 | 9 | 15 | 0 | 7 | 10 | 0 |
| Extreme range in 40 years. | 118.55 | 25.25 | 26 | 00 | 0 | 5 | 2 | 6 |

### HIGHEST AND LOWEST PRICES PER FLASK PREVAILING AT HONGKONG FOR QUICKSILVER, BY MONTHS AND YEARS, FOR THE DECADE 1880–1889. (*a*)

| MONTHS. | 1880. | | 1881. | | 1882. | | 1883. | | 1884. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. |
| January | $59.75 | $59.00 | $56.75 | $56.25 | $58.25 | $57.25 | $56.50 | $55.25 | $53.00 | $52.00 |
| February | 65.00 | 59.00 | 58.25 | 57.75 | 57.50 | 57.00 | 56.25 | 55.00 | 53.80 | 52.00 |
| March | 62.50 | 59.50 | 57.50 | 57.00 | 58.00 | 57.50 | 57.00 | 55.75 | 55.00 | 52.50 |
| April | 62.25 | 59.75 | 59.50 | 58.00 | 57.75 | 56.50 | 56.25 | 55.75 | 56.00 | 54.75 |
| May | 60.50 | 58.25 | 58.50 | 57.75 | 57.50 | 56.75 | 56.00 | 55.75 | 56.50 | 54.75 |
| June | 58.75 | 55.75 | 59.00 | 57.50 | 57.25 | 56.00 | 56.50 | 56.25 | 55.00 | 52.25 |
| July | 57.50 | 55.75 | 58.50 | 58.00 | 56.00 | 55.75 | 57.25 | 56.00 | 53.40 | 51.75 |
| August | 60.50 | 57.75 | 58.25 | 57.50 | 57.25 | 56.50 | 56.50 | 56.00 | 52.00 | 61.00 |
| September | 61.75 | 60.25 | 57.75 | 57.00 | 57.25 | 57.00 | 55.75 | 54.50 | 52.00 | 51.50 |
| October | 60.50 | 58.75 | 58.50 | 58.00 | 57.25 | 57.00 | 54.00 | 52.75 | 54.50 | 52.00 |
| November | 58.75 | 57.75 | 58.50 | 58.00 | 57.50 | 57.25 | 54.50 | 52.75 | 62.00 | 54.00 |
| December | 57.50 | 56.20 | 58.75 | 58.00 | 57.50 | 56.50 | 54.00 | 53.00 | 69.00 | 62.50 |

| MONTHS. | 1885. | | 1886. | | 1887. | | 1888. | | 1889. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. | Highest. | Lowest. |
| January | $68.00 | $67.00 | $66.00 | $64.00 | $83.00 | $79.00 | $115.00 | $92.00 | $100.00 | $93.50 |
| February | 67.50 | 66.50 | 66.50 | 65.75 | 83.50 | 81.50 | 95.00 | 94.00 | 96.00 | 94.00 |
| March | 67.50 | 59.00 | 66.00 | 65.00 | 83.50 | 82.50 | 90.00 | 88.00 | 93.00 | 90.00 |
| April | 61.00 | 59.00 | 65.00 | 64.50 | 83.00 | 82.00 | 88.00 | 85.50 | 94.50 | 93.00 |
| May | 59.50 | 58.00 | 66.00 | 65.50 | 82.50 | 78.00 | 85.00 | 81.00 | 95.00 | 93.50 |
| June | 61.00 | 58.00 | 75.00 | 67.50 | .......... | 78.00 | 93.00 | 92.00 | 100.50 | 94.00 |
| July | 60.00 | 57.50 | 81.00 | 74.00 | 80.50 | 80.00 | 92.50 | 91.00 | 116.00 | 101.00 |
| August | 62.50 | 59.50 | 82.50 | 82.00 | 83.00 | 79.00 | 92.00 | 88.50 | 115.00 | 102.00 |
| September | 63.00 | 59.75 | 82.00 | 81.00 | 85.50 | 85.00 | 99.50 | 96.00 | 111.00 | 107.00 |
| October | 62.50 | 60.75 | 84.50 | 84.00 | 88.50 | 87.00 | 101.00 | 97.00 | 106.00 | 103.00 |
| November | 62.00 | 59.50 | 82.50 | 78.50 | 89.00 | 87.50 | 99.50 | 99.00 | 107.50 | 106.00 |
| December | 66.50 | 64.50 | 78.00 | 77.00 | 115.00 | 103.00 | 97.00 | 96.00 | 108.00 | 105.00 |

*a* During which time the lowest price reached was in August, 1884, $51 to $52, and the highest in July, 1889, $101 to $116.

## DISTRIBUTION OF QUICKSILVER.

### TOTAL EXPORTS AND SHIPMENTS OF QUICKSILVER IN 1889.

BY SEA.

| | FLASKS. | | |
|---|---|---|---|
| To Mexico | 4,593 | | |
| To Central America | 47 | | |
| To Chile and South America | 10 | | |
| To New Zealand | 112 | | |
| To Australia | 10 | | |
| To British Columbia | 11 | | |
| | | 4,783 | |
| Shipments to New York | | 430 | |
| Total by sea | | | 5,213 |

BY RAILROAD.

| | | | |
|---|---|---|---|
| From San Jose, California: | | | |
| To New York | 5,100 | | |
| To Texas | 200 | | |
| To Montana | 1,995 | | |
| To Utah | 118 | | |
| To Idaho | 100 | | |
| To Arizona | 90 | | |
| | | 7,603 | |
| From San Francisco, California: | | | |
| To New York | 1,500 | | |
| To Mexico | 819 | | |
| To Montana, Idaho, and Utah | 2,311 | | |
| To Arizona | 110 | | |
| To Colorado | 61 | | |
| | | 4,801 | |
| From San Francisco, via Portland and Northern Pacific railroad, to Montana | | 350 | |
| Add for shipments to Montana, Idaho, and Arizona not included in above | | 533 | |
| Total by railroad | | | 13,287 |
| Total shipments by sea and railroad | | | 18,500 |

SHIPMENTS OF QUICKSILVER IN BOND FROM SAN FRANCISCO. (a)

| YEARS. | Spanish, in bond to— | Flasks. | Value. |
|---|---|---|---|
| Total |  | 1,100 | $36,619 |
| 1886 | Mexico | 500 | 13,719 |
| 1887 | Hongkong | 500 | 18,300 |
| 1889 | Mexico | 100 | 4,600 |

a Reported by the San Francisco customhouse.

SHIPMENTS OF QUICKSILVER OVERLAND TO POINTS EAST FOR THE 10 YEARS ENDED DECEMBER 31, 1889, VIA THE CENTRAL PACIFIC RAILROAD. (a)

|  | FLASKS. |
|---|---|
| 1880 | 15,553 |
| 1881 | 13,555 |
| 1882 | 7,996 |
| 1883 | 5,211 |
| 1884 | 2,830 |
| 1885 | 9,096 |
| 1886 | 8,039 |
| 1887 | 5,859 |
| 1888 | 3,622 |
| 1889 | 6,889 |

a Compiled from annual reports of the San Francisco Journal of Commerce.

## IMPORTS.

The following table, compiled from the records of the bureau of statistics of the Treasury department, shows the amounts of quicksilver reported by the collectors of customs as imported in each year for 10 years. The original figures are reported in pounds, and sometimes include the weight of the iron flask. The importations in 1890 increased materially, amounting to 10,482 flasks, valued at $445,857.

QUICKSILVER IMPORTED AND ENTERED FOR CONSUMPTION IN THE UNITED STATES, 1880 TO 1889, INCLUSIVE.

| YEARS ENDING— | Flasks. | Value. |
|---|---|---|
| June 30, 1880 | 1,296 | $48,463 |
| 1881 | 1,539 | 57,733 |
| 1882 | 6,643 | 233,057 |
| 1883 | 17,253 | 593,367 |
| 1884 | 1,518 | 44,035 |
| 1885 | 2,866 | 90,416 |
| Dec. 31, 1886 | 4,468 | 142,325 |
| 1887 | 7,706 | 290,380 |
| 1888 | 1,730 | 56,997 |
| 1889 | 4,464 | 162,064 |

## IMPORT DUTIES AND EXPORTS.

The following is a comparative statement of the rates of import duty on quicksilver under the several tariff acts from July 30, 1846, to October 1, 1890, both inclusive:

IMPORT DUTIES ON QUICKSILVER.

| Act of— |  |  |
|---|---|---|
| July 30, 1846 | per cent | 20 |
| March 3, 1857 | do | 15 |
| March 2, 1861 | do | 10 |
| August 5, 1861 | do | 10 |
| December 24, 1861 | do | 10 |
| July 14, 1862 | do | 10 |
| March 3, 1863 | do | 10 |
| June 30, 1864 | do | 10 and 15 |
| March 3, 1865 | do | 10 and 15 |
| March 16, 1866 | do | 10 and 15 |
| May 16, 1866 | do | 10 and 15 |
| June 1, 1866 | do | 10 and 15 |
| July 28, 1866 | do | 15 |
| March 2, 1867 | per cent | 15 |
| March 22, 1867 | do | 15 |
| March 25–26, 1867 | do | 15 |
| March 29, 1867 | do | 15 |
| February 3, 1868 | do | 15 |
| July 20, 1868 | do | 15 |
| February 19–24, 1869 | do | 15 |
| July 14, 1870 | do | 15 |
| December 22, 1870 | do | 15 |
| May 1, 1872 | per cent of existing duties | 90 |
| June 6, 1872 | do | 90 |
| March 3, 1883 | per cent | 10 |
| October 1, 1890 | cents per pound | 10 |

Under the tariff act of October 1, 1890, the flasks, bottles, or other vessels in which quicksilver may be imported are subjecet to the same rate of duty as they would be if imported empty. Quicksilver flasks or bottles of either domestic or foreign manufacture which have been actually exported from the United States are entitled to free entry.

### CUSTOMS DUTIES IMPOSED BY FOREIGN NATIONS UPON AMERICAN QUICKSILVER. (*a*)

| | |
|---|---|
| Brazil | $5.70 per 100 pounds. |
| China | $2.60 per 133.3 pounds |
| Corea | 7.5 per cent ad valorem. |
| Ecuador | $8.52 per 100 pounds. |
| Greece | 73 cents per 100 pounds. |
| Hawaiian Islands | 10 per cent ad valorem. |
| Haiti | 20 per cent ad valorem. |
| Honduras | $1.66 for 104 pounds. |
| Italy—Quicksilver | $1.93 for 220.464 pounds. |
| Oxide of mercury, muriate of mercury, chloride of mercury, precipitate of mercury | $0.77 for 220.464 pounds. |
| Calomel | $23.16 for 220.464 pounds. |
| Vermilion | $4.83 for 220.464 pounds. |
| Japan | $1.58 for 131 pounds. |
| New South Wales | 5 per cent ad valorem. |
| Peru | 10 per cent ad valorem. |
| Porto Rico | $2.72 for 220.464 pounds. |
| Russia | $1.20 for 36 pounds. |
| San Salvador | 5 per cent ad valorem. |
| Spain | 31 cents for 220.464 pounds. |
| Sweden | $4.76 for 100 pounds. |
| Switzerland | 58 cents for 110 pounds. |
| Turkey | $7.04 for 220 pounds. |
| United States of Colombia | $9.90 per 100 pounds. |
| Uruguay | 47 per cent ad valorem. |
| Venezuela | $11.05 for 100 pounds. |

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*a* The report is taken from United States consular report No. 73½, Washington, 1887; all in United States weight and currency.

### EXPORTS OF DOMESTIC QUICKSILVER FROM THE UNITED STATES FOR THE 10 YEARS ENDED DECEMBER 31, 1889.

[Compiled from the returns sent in by the various collectors of customs.]

| PORTS. | TOTAL. | | 1880. | | 1881. | | 1882. | | 1883. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Flasks. | Dollars. | Flasks. | Dollars. | Flasks. | Dollars. | Flasks. | Dollars. | Flasks. | Dollars. |
| Total | 183, 716 | 5, 617, 685 | 37, 210 | 1, 119, 952 | 35, 107 | 1, 025, 299 | 33, 875 | 988, 454 | 30, 072 | 808, 353 |
| Ports from which exported— | | | | | | | | | | |
| San Francisco | 176, 974 | 5, 378, 118 | 34, 359 | 1, 028, 826 | 33, 935 | 985, 927 | 33, 728 | 983, 977 | 29, 928 | 804, 077 |
| New York | 6, 066 | 223, 049 | 2, 221 | 76, 244 | 1, 166 | 39, 161 | 143 | 4, 344 | 137 | 4, 037 |
| Philadelphia | 630 | 14, 882 | 630 | 14, 882 | | | | | | |
| Boston | 40 | 1, 454 | | | 6 | 211 | 4 | 133 | 7 | 239 |
| New Orleans | [illegible] | 182 | | | | | | | | |
| Total | 183, 716 | 5, 617, 685 | 37, 210 | 1, 119, 952 | 35, 107 | 1, 025, 299 | 33, 875 | 988, 454 | 30, 072 | 808, 353 |
| Exported to— | | | | | | | | | | |
| Hongkong | 79, 451 | 2, 371, 108 | 19, 610 | 577, 019 | 17, 031 | 493, 171 | 18, 965 | 560, 353 | 16, 356 | 438, 689 |
| Central American States | 2, 594 | 94, 294 | 41 | 1, 095 | 38 | 1, 086 | 75 | 2, 151 | 150 | 4, 263 |
| Chile | 3, 543 | 105, 309 | 754 | 24, 842 | 123 | 3, 700 | 1, 400 | 42, 000 | 1, 150 | 31, 250 |
| China | 87 | 2, 861 | 50 | 1, 475 | | | | | | |
| Germany | | | | | | | | | | |
| England | 2, 553 | 96, 082 | 1, 753 | 59, 882 | | | | | | |
| British Columbia | 205 | 6, 406 | 7 | 211 | 5 | 141 | 16 | 472 | 4 | 110 |
| British possessions in Australasia | 6, 332 | 190, 638 | 1, 535 | 47, 874 | 1, 330 | 37, 249 | 1, 831 | 52, 997 | 786 | 20, 766 |
| Japan | 3, 344 | 88, 705 | 105 | 3, 050 | 314 | 9, 213 | 621 | 17, 601 | 1, 297 | 32, 151 |
| Mexico | 82, 172 | 2, 558, 030 | 12, 413 | 376, 007 | 15, 256 | 450, 448 | 10, 128 | 288, 441 | 10, 157 | 276, 332 |
| Peru | 1, 955 | 57, 231 | 440 | 13, 540 | 700 | 20, 161 | 665 | 19, 285 | 100 | 2, 695 |
| Cuba | 377 | 11, 083 | 356 | 10, 270 | | | 1 | 33 | | |
| United States of Colombia | 581 | 19, 118 | 115 | 3, 673 | 208 | 6, 487 | 45 | 1, 280 | 11 | 326 |
| Venezuela | 333 | 10, 694 | 13 | 497 | 80 | 3, 225 | 98 | 2, 941 | 56 | 1, 028 |
| Dutch Guiana | 37 | 1, 399 | 1 | 26 | 12 | 418 | 4 | 133 | 5 | 175 |
| Nova Scotia, New Brunswick, and Prince Edward Island. | 23 | 905 | | | | | | | 2 | 64 |
| West Indies | 55 | 1, 629 | | | | | 18 | 552 | 18 | 504 |
| All other ports | 74 | 2, 193 | 17 | 491 | | | 8 | 215 | | |

EXPORTS OF DOMESTIC QUICKSILVER FROM THE UNITED STATES, ETC.—Continued.

| PORTS. | 1884. |  | 1885. |  | 1886. |  | 1887. |  | 1888. |  | 1889. |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | Flasks. | Dollars. | Flasks. | Dollars. | Flasks. | Dollars. | Flasks. | Dollars. | Flasks. | Dollars. | Flasks. | Dollars. |
| Total | 7,370 | 199,685 | 6,802 | 209,758 | 6,091 | 204,956 | 11,394 | 441,112 | 10,684 | 406,399 | 5,111 | 213,717 |
| Ports from which exported— |  |  |  |  |  |  |  |  |  |  |  |  |
| San Francisco | 7,037 | 189,420 | 6,547 | 200,739 | 5,845 | 196,384 | 10,401 | 396,316 | 10,145 | 381,707 | 5,049 | 210,745 |
| New York | 332 | 10,233 | 242 | 8,578 | 240 | 8,340 | 984 | 44,448 | 539 | 24,692 | 62 | 2,972 |
| Philadelphia |  |  |  |  |  |  |  |  |  |  |  |  |
| Boston |  |  | 8 | 291 | 6 | 232 | 9 | 348 |  |  |  |  |
| New Orleans | 1 | 32 | 5 | 150 |  |  |  |  |  |  |  |  |
| Total | 7,370 | 199,685 | 6,802 | 209,758 | 6,091 | 204,956 | 11,394 | 441,112 | 10,684 | 406,399 | 5,111 | 213,717 |
| Exported to— |  |  |  |  |  |  |  |  |  |  |  |  |
| Hongkong | 220 | 6,750 | 233 | 8,990 |  |  | 3,323 | 141,237 | 3,713 | 144,899 |  |  |
| Central American States | 285 | 8,390 | 238 | 8,341 | 164 | 5,805 | 177 | 6,466 | 1,333 | 52,586 | 93 | 4,111 |
| Chile |  |  | 104 | 3,042 |  |  |  |  |  |  | 12 | 475 |
| China |  |  |  |  |  |  |  |  | 37 | 1,386 |  |  |
| Germany |  |  |  |  |  |  |  |  |  |  |  |  |
| England |  |  |  |  |  |  | 800 | 36,200 |  |  |  |  |
| British Columbia | 15 | 406 | 40 | 1,088 | 59 | 1,902 | 31 | 1,104 | 16 | 548 | 12 | 424 |
| British possessions in Australasia | 130 | 3,768 | 75 | 2,257 | 90 | 3,295 | 100 | 3,965 | 322 | 12,979 | 133 | 5,488 |
| Japan | 669 | 16,032 | 300 | 9,100 | 3 | 108 |  |  | 35 | 1,450 |  |  |
| Mexico | 5,830 | 157,758 | 5,777 | 175,828 | 5,678 | 190,461 | 6,920 | 250,514 | 5,172 | 190,013 | 4,841 | 202,228 |
| Peru | 50 | 1,550 |  |  |  |  |  |  |  |  |  |  |
| Cuba | 11 | 351 |  |  | 5 | 180 |  |  | 2 | 127 | 2 | 122 |
| United States of Colombia | 80 | 2,376 | 14 | 498 | 22 | 873 | 32 | 1,196 | 48 | 2,096 | 6 | 313 |
| Venezuela | 36 | 1,057 |  |  | 60 | 1,946 |  |  |  |  |  |  |
| Dutch Guiana |  |  | 5 | 176 | 2 | 77 | 3 | 129 | 5 | 265 |  |  |
| Nova Scotia, New Brunswick, and Prince Edward Island. |  |  | 2 | 76 | 6 | 232 | 7 | 261 |  |  | 6 | 272 |
| West Indies | 18 | 529 |  |  | 1 | 44 |  |  |  |  |  |  |
| All other ports | 26 | 718 | 14 | 362 | 1 | 33 | 1 | 40 | 1 | 50 | 6 | 284 |

## ENGLISH QUICKSILVER MOVEMENTS.

The control of the quicksilver market is usually affected by the transactions in London, a résumé of which is given in the following tables, which show a synopsis of the statistical features of each of the past 10 years. The shipments of quicskilver to the United States are also shown.

### EXPORTS OF QUICKSILVER FROM ENGLAND.

[Flasks.]

| EXPORTED TO— | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. | 1886. | 1887. | 1888. | 1889. |
|---|---|---|---|---|---|---|---|---|---|---|
| Total | 16,023 | 24,889 | 40,424 | 49,006 | 52,548 | 48,865 | 66,109 | 62,606 | 47,133 | 57,604 |
| Russia | 1,117 | 1,539 | 1,451 | 1,156 | 769 | 1,595 | 1,031 | 399 | 45 | 72 |
| Germany | 2,504 | 2,053 | 2,974 | 3,906 | 2,224 | 2,916 | 3,557 | 3,542 | 4,098 | 3,278 |
| Holland | 692 | 708 | 941 | 702 | 819 | 843 | 853 | 1,254 | 633 | 1,323 |
| Belgium | 285 | 742 | 779 | 868 | 729 | 507 | 816 | 608 | 725 | ... |
| Channel Islands | 127 | 70 | 131 | 75 | 85 | 142 | 118 | 97 | 40 | 67 |
| France | 3,997 | 6,143 | 6,871 | 5,083 | 4,492 | 6,854 | 4,553 | 7,718 | 4,884 | 8,995 |
| Portugal | 465 | 530 | 452 | 444 | 442 | 609 | 445 | 447 | ... | ... |
| Spain | 47 | 51 | 21 | 97 |  | ... | ... |  | 475 | 412 |
| Turkey | 24 | 79 | 93 | 123 | 85 | 136 | 97 | 46 | 33 | 42 |
| Roumania and Bulgaria | ... | 24 | ... | ... | ... | ... | ... | ... | ... | ... |
| Roumania and Greece | ... | ... | ... | ... | 26 | ... | ... | ... | ... | ... |
| Morocco | ... | ... | 3 | ... | ... | 9 | 12 | ... | 11 | ... |
| Persia | ... | ... | ... | ... | 4 | ... | ... | ... | ... | ... |
| Gold Coast | 5 | 16 | 77 | 131 | 52 | ... | 49 | 33 | 77 | ... |
| South Australia | 5 | 11 | 150 | ... | ... | 20 | ... | ... | ... | ... |
| Natal | ... | ... | ... | ... | 302 | 94 | ... | ... | ... | ... |
| Cape of Good Hope | ... | ... | ... | ... | 60 | ... | ... | ... | ... | ... |
| Natal and Cape of Good Hope | ... | ... | ... | ... | ... | ... | 194 | 971 | 742 | 239 |
| United States | 200 | 4,659 | 13,116 | 14,382 | 4,871 | 5,112 | 12,311 | 10,554 | 4,649 | 7,967 |
| Dutch West Indies | 22 | 60 | 64 | 87 | 234 | 76 | ... | ... | 200 | 4 |
| Mexico | 2,631 | 5,043 | 5,562 | 5,120 | 5,551 | 5,680 | 10,592 | 6,545 | 9,967 | 6,168 |
| Central America | 370 | 230 | 122 | 233 | 217 | 156 | 188 | 124 | 253 | 197 |
| United States of Colombia | ... | 333 | 238 | 202 | 408 | 409 | 63 | 221 | 180 | 620 |
| Canary Islands | ... | ... | ... | ... | 1 | ... | ... | ... | ... | ... |
| Peru | 936 | 970 | 2,147 | 2,198 | 1,767 | 2,276 | 3,188 | 2,025 | 2,389 | 4,430 |
| Brazil | 67 | 22 | 50 | 216 | 189 | 212 | 173 | 126 | 189 | ... |
| Argentine Republic | 1,877 | 331 | 2,083 | 1,591 | 850 | 339 | 114 | 148 | 416 | 434 |
| Norway | 4 | 2 | 94 |  |  |  |  |  |  |  |
| Denmark | 31 | 46 |  | 88 | 92 | 48 | 49 | 104 | 78 | 42 |
| Sweden | 35 | 32 |  |  |  |  |  |  |  |  |
| Italy | 31 | 79 | 33 | 52 | 40 | 15 | 11 | 27 | 8 | 76 |
| Egypt | 25 | 37 | 19 | 10 | 55 | 1 | 16 | 15 | ... | 154 |
| Bengal | ... | 50 | 392 | 2,750 | 920 | 953 | 1,498 | 1,559 | 1,506 | ... |
| Java | ... | ... | ... | ... | 40 | ... | ... | ... | ... | ... |
| Java and Ceylon | ... | ... | ... | ... | ... | 5 | ... | ... | ... | ... |
| Victoria | 42 | 162 | 390 | 134 | 75 | 886 | 194 | 826 | 457 | 1 |
| New Zealand | 37 | 61 | 61 | 80 | 54 | 28 | 34 | 216 | 176 | 69 |
| Chile | 314 | 298 | 647 | 1,496 | 1,308 | 2,085 | 2,297 | 2,625 | 1,442 | ... |
| Japan | ... | ... | ... | ... | 750 | 10 | 810 | ... | 334 | 1,006 |
| China | ... | 12 | 10 | 1,301 | 10 | ... | ... | ... | ... | ... |
| Hongkong | ... | ... | ... | 4,509 | 23,924 | 14,054 | 21,515 | 19,208 | 10,267 | 16,807 |
| Bombay | 75 | 15 | 730 | ... | 868 | 1,527 | 869 | 1,551 | 1,570 | ... |
| Madras | 11 | 392 | 1 | ... | 12 | 55 | 36 | 63 | ... | 3,585 |
| Bombay and Madras | ... | ... | ... | 1,707 | ... | ... | ... | ... | ... | ... |
| Canada | 1 | 3 | 11 | ... | 41 | 23 | 19 | 332 | 13 | 81 |
| Newfoundland | ... | ... | ... | ... | ... | ... | 2 | ... | ... | ... |
| British Burmah | ... | 25 | 31 | 94 | 12 | ... | ... | ... | ... | ... |
| Uruguay | 34 | ... | 8 | ... | 5 | 9 | 10 | 10 | 154 | ... |
| Spanish West Indies | ... | ... | 500 | ... | 1 | ... | 69 | ... | ... | ... |
| New South Wales | 12 | 57 | ... | 112 | 82 | 716 | 29 | 435 | 244 | 1,535 |
| Queensland | ... | 4 | ... | 59 | 82 | 465 | 297 | 619 | 878 | ... |
| Queensland and New South Wales | ... | ... | 163 | ... | ... | ... | ... | ... | ... | ... |
| Philippine Islands | ... | ... | ... | ... | ... | ... | ... | 6 | ... | ... |
| Bolivia | ... | ... | ... | ... | ... | ... | ... | 152 | ... | ... |

## ENGLISH IMPORTS AND EXPORTS OF QUICKSILVER FOR 10 YEARS, BY MONTHS.

### IMPORTS.

[Flasks.]

| MONTHS. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. | 1886. | 1887. | 1888. | 1889. |
|---|---|---|---|---|---|---|---|---|---|---|
| Total | 49,544 | 56,259 | 45,036 | 54,521 | 59,969 | 55,154 | 58,967 | 61,114 | 73,768 | 67,529 |
| January | 6,692 | 8,680 | 7,608 | 362 | 4,617 | 4,350 | 4,496 | 9,404 | 11,440 | 7,250 |
| February | 16,380 | 4,187 | 4,300 | 3,270 | 5,127 | 4,603 | 12,488 | 9,641 | 10,750 | 8,546 |
| March | 4,117 | 12,211 | 7,947 | 8,300 | 20,327 | 8,434 | 7,179 | 4,180 | 13,844 | 6,591 |
| April | 7,778 | 5,310 | 10,607 | 4,082 | 7,087 | 329 | 6,036 | 11,752 | 7,960 | 12,630 |
| May | 6,118 | 5,600 | 4,546 | 11,602 | 9,055 | 9,545 | 10,436 | 4,200 | 4,237 | 1,857 |
| June | 2,173 | 9,487 | 6,490 | 6,482 | 4,628 | 21,328 | 9,130 | 11,700 | 14,902 | 15,266 |
| July | 504 | 368 | .......... | 18,266 | 3,802 | 427 | 4,458 | 4,754 | 300 | 2,479 |
| August | 891 | 600 | 1,178 | 529 | 1,283 | 1,607 | 1,289 | 1,200 | 26 | 1,035 |
| September | 1,400 | .......... | 600 | 550 | 500 | 300 | 850 | 510 | 1,670 | 3,329 |
| October | 2,111 | 600 | 960 | 218 | 1,340 | 2,057 | 1,201 | 1,298 | 646 | 944 |
| November | 1,080 | 527 | .......... | 410 | 800 | 474 | 1,004 | 275 | 1,273 | 1,705 |
| December | 300 | 8,689 | 800 | 450 | 1,403 | 1,700 | 400 | 2,200 | 6,720 | 5,897 |

### EXPORTS.

| MONTHS. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. | 1886. | 1887. | 1888. | 1889. |
|---|---|---|---|---|---|---|---|---|---|---|
| Total | 16,023 | 24,889 | 40,424 | 49,006 | 52,548 | 48,865 | 66,109 | 62,606 | 47,133 | 57,604 |
| January | 1,288 | 2,079 | 1,947 | 5,192 | 4,410 | 2,524 | 3,793 | 5,973 | 2,181 | 4,492 |
| February | 713 | 1,165 | 2,387 | 4,009 | 4,912 | 3,914 | 4,906 | 3,232 | 1,573 | 4,481 |
| March | 1,075 | 2,136 | 3,382 | 3,348 | 3,412 | 3,916 | 10,273 | 4,866 | 2,411 | 7,756 |
| April | 1,265 | 2,126 | 3,417 | 4,658 | 2,035 | 2,983 | 8,842 | 6,375 | 4,185 | 8,749 |
| May | 985 | 2,540 | 2,558 | 4,407 | 6,305 | 3,204 | 5,556 | 4,053 | 11,917 | 5,295 |
| June | 2,252 | 1,414 | 4,951 | 4,604 | 5,926 | 4,915 | 6,655 | 7,470 | 5,867 | 2,238 |
| July | 1,367 | 1,323 | 2,809 | 3,718 | 5,646 | 3,123 | 4,371 | 8,244 | 3,248 | 2,483 |
| August | 794 | 2,135 | 4,187 | 2,342 | 3,153 | 6,488 | 3,951 | 6,245 | 3,367 | 5,375 |
| September | 1,583 | 2,406 | 2,772 | 3,242 | 3,734 | 9,642 | 8,055 | 3,366 | 3,714 | 4,621 |
| October | 911 | 2,042 | 3,371 | 4,253 | 3,071 | 2,366 | 2,542 | 4,320 | 1,333 | 4,714 |
| November | 1,963 | 2,576 | 4,260 | 6,069 | 4,335 | 1,943 | 3,310 | 6,117 | 4,142 | 2,523 |
| December | 1,827 | 2,947 | 4,383 | 3,164 | 5,609 | 3,847 | 3,855 | 2,345 | 3,195 | 4,877 |

## LONDON PRICES PER FLASK OF QUICKSILVER.

### 1880.

| DATE. | Price. | | | DATE. | Price. | | | DATE. | Price. | | | DATE. | Price. | | | DATE. | Price. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | £ | s. | d. | | £ | s. | d. | | £ | s. | d. | | £ | s. | d. | | £ | s. | d. |
| January 3 | 6 | 10 | 0 | January 9 | 7 | 7 | 6 | February 11 | 7 | 0 | 0 | July 13 | 7 | 2 | 6 | August 4 | 7 | 5 | 0 |
| January 5 | 6 | 17 | 6 | January 14 | 7 | 0 | 0 | February 21 | 7 | 2 | 6 | July 13 | 7 | 5 | 0 | August 16 | 7 | 0 | 0 |
| January 5 | 7 | 0 | 0 | January 14 | 6 | 17 | 6 | February 23 | 7 | 10 | 0 | July 17 | 7 | 5 | 0 | September 22 | 6 | 17 | 6 |
| January 6 | 7 | 15 | 0 | January 22 | 7 | 5 | 0 | March 8 | 7 | 0 | 0 | July 17 | 7 | 2 | 6 | November 3 | 6 | 15 | 0 |
| January 6 | 7 | 7 | 6 | January 22 | 7 | 10 | 0 | April 7 | 6 | 15 | 0 | July 17 | 7 | 0 | 0 | November 23 | 6 | 10 | 0 |
| January 6 | 7 | 12 | 6 | January 29 | 7 | 7 | 6 | May 25 | 6 | 10 | 0 | July 23 | 6 | 17 | 6 | December 22 | 6 | 7 | 6 |
| January 9 | 7 | 10 | 0 | January 29 | 7 | 5 | 0 | June 23 | 6 | 15 | 0 | July 23 | 6 | 15 | 0 | | | | |

### 1881.

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January 7 | 6 | 10 | 0 | March 22 | 6 | 10 | 0 | May 19 | 6 | 5 | 0 | September 26 | 6 | 10 | 0 | November 15 | 6 | 5 | 0 |
| January 31 | 6 | 15 | 0 | April 4 | 6 | 5 | 0 | July 5 | 6 | 7 | 6 | October 11 | 6 | 15 | 0 | November 22 | 6 | 7 | 0 |
| February 8 | 7 | 0 | 0 | April 26 | 6 | 7 | 6 | July 7 | 6 | 10 | 0 | October 13 | 7 | 0 | 0 | November 23 | 6 | 10 | 0 |
| March 3 | 6 | 15 | 0 | April 27 | 6 | 10 | 0 | August 12 | 6 | 5 | 0 | November 7 | 6 | 10 | 0 | December 1 | 6 | 5 | 0 |
| March 3 | 6 | 13 | 9 | May 7 | 6 | 7 | 6 | | | | | | | | | | | | |

### 1882.

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January 1 | 6 | 5 | 0 | April 18 | 6 | 5 | 0 | June 6 | 5 | 18 | 9 | September 9 | 6 | 0 | 0 | November 14 | 5 | 16 | 9 |
| January 24 | 6 | 0 | 0 | May 15 | 6 | 0 | 0 | July 18 | 5 | 17 | 6 | October 23 | 5 | 17 | 6 | December 29 | 5 | 15 | 0 |
| March 18 | 5 | 17 | 6 | June 1 | 5 | 17 | 6 | | | | | | | | | | | | |

## LONDON PRICES PER FLASK OF QUICKSILVER—Continued.

### 1883.

| DATE. | Price. | | | DATE. | Price. | | | DATE. | Price. | | | DATE. | Price. | | | DATE. | Price. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | £ | s. | d. | | £ | s. | d. | | £ | s. | d. | | £ | s. | d. | | £ | s. | d. |
| January 4 | 5 | 10 | 0 | February 17 | 5 | 17 | 6 | April 3 | 5 | 12 | 6 | July 13 | 5 | 10 | 0 | October 1 | 5 | 5 | 0 |
| February 14 | 5 | 12 | 6 | March 13 | 5 | 15 | 0 | April 28 | 5 | 10 | 0 | July 20 | 5 | 12 | 6 | November 19 | 5 | 7 | 6 |
| February 15 | 5 | 15 | 0 | March 20 | 5 | 10 | 0 | June 21 | 5 | 7 | 6 | August 28 | 5 | 7 | 6 | December 20 | 5 | 5 | 0 |

### 1884.

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| February 2 | 5 | 2 | 6 | May 27 | 5 | 7 | 6 | July 24 | 5 | 6 | 3 | November 12 | 5 | 17 | 6 | November 20 | 6 | 10 | 0 |
| February 23 | 5 | 5 | 0 | June 10 | 5 | 3 | 6 | August 18 | 5 | 7 | 6 | November 17 | 6 | 0 | 0 | November 21 | 6 | 15 | 0 |
| February 29 | 5 | 10 | 0 | June 23 | 5 | 5 | 0 | August 27 | 5 | 10 | 0 | November 18 | 6 | 5 | 0 | November 29 | 6 | 15 | 0 |
| March 6 | 5 | 12 | 6 | July 3 | 5 | 7 | 6 | September 17 | 5 | 12 | 0 | November 19 | 6 | 7 | 6 | November 29 | 6 | 17 | 6 |
| April 1 | 5 | 10 | 0 | July 22 | 5 | 5 | 0 | November 10 | 5 | 15 | 0 | | | | | | | | |

### 1885.

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| March 13 | 6 | 0 | 0 | May 13 | 5 | 12 | 6 | August 7 | 5 | 15 | 0 | November 9 | 5 | 17 | 6 | November 20 | 6 | 0 | 0 |
| March 13 | 6 | 15 | 0 | June 1 | 5 | 15 | 0 | August 11 | 5 | 17 | 6 | November 11 | 5 | 16 | 3 | November 23 | 6 | 3 | 6 |
| April 30 | 5 | 12 | 6 | June 2 | 6 | 0 | 0 | September 14 | 6 | 0 | 0 | November 19 | 5 | 17 | 6 | November 24 | 6 | 5 | 0 |
| May 5 | 5 | 10 | 0 | July 20 | 5 | 12 | 6 | September 17 | 6 | 2 | 6 | | | | | | | | |

### 1886.

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January 4 | 6 | 0 | 0 | March 8 | 5 | 16 | 3 | April 30 | 6 | 5 | 0 | July 7 | 7 | 0 | 0 | September 21 | 7 | 5 | 0 |
| January 21 | 5 | 17 | 6 | March 10 | 5 | 17 | 6 | May 14 | 6 | 10 | 0 | September 6 | 6 | 16 | 0 | September 23 | 7 | 10 | 0 |
| January 22 | 6 | 0 | 0 | April 5 | 5 | 16 | 3 | June 4 | 6 | 15 | 0 | September 13 | 7 | 0 | 0 | November 16 | 7 | 2 | 6 |
| February 23 | 5 | 17 | 6 | April 7 | 6 | 0 | 0 | June 10 | 6 | 17 | 6 | September 20 | 7 | 2 | 6 | November 18 | 7 | 5 | 0 |
| March 1 | 5 | 15 | 0 | | | | | | | | | | | | | | | | |

### 1887.

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January 1 | 7 | 5 | 0 | May 23 | 6 | 10 | 0 | August 9 | 7 | 5 | 0 | November 30 | 9 | 5 | 0 | December 9 | 9 | 10 | 0 |
| January 6 | 7 | 7 | 6 | May 24 | 6 | 12 | 6 | August 29 | 7 | 10 | 0 | November 30 | 9 | 15 | 0 | December 10 | 9 | 15 | 0 |
| March 11 | 7 | 2 | 6 | June 17 | 6 | 11 | 0 | October 1 | 7 | 12 | 6 | December 1 | 10 | 5 | 0 | December 10 | 10 | 5 | 0 |
| March 14 | 7 | 0 | 0 | June 23 | 6 | 12 | 6 | October 10 | 7 | 15 | 0 | December 2 | 10 | 10 | 0 | December 10 | 10 | 10 | 0 |
| March 26 | 6 | 17 | 6 | July 7 | 6 | 15 | 0 | November 29 | 8 | 0 | 0 | December 6 | 10 | 10 | 0 | December 12 | 11 | 5 | 0 |
| March 28 | 7 | 0 | 0 | July 11 | 6 | 17 | 6 | November 30 | 9 | 0 | 0 | December 6 | 10 | 5 | 0 | December 12 | 11 | 0 | 0 |
| May 2 | 6 | 17 | 6 | August 8 | 7 | 0 | 0 | | | | | | | | | | | | |

### 1888.

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January 5 | 10 | 0 | 0 | February 21 | 8 | 10 | 0 | May 10 | 6 | 15 | 0 | July 17 | 7 | 7 | 6 | September 15 | 8 | 12 | 6 |
| January 14 | 9 | 5 | 0 | March 6 | 8 | 2 | 6 | May 23 | 7 | 2 | 6 | July 17 | 7 | 7 | 6 | September 15 | 8 | 15 | 0 |
| January 17 | 9 | 10 | 0 | March 20 | 8 | 0 | 0 | May 24 | 7 | 0 | 0 | July 20 | 7 | 5 | 0 | October 16 | 9 | 0 | 0 |
| January 18 | 8 | 15 | 0 | March 23 | 7 | 15 | 0 | May 28 | 7 | 2 | 6 | July 31 | 7 | 7 | 6 | October 17 | 9 | 10 | 0 |
| January 20 | 9 | 0 | 0 | April 9 | 7 | 15 | 0 | June 4 | 7 | 5 | 0 | August 2 | 7 | 12 | 6 | October 19 | 9 | 1 | 0 |
| February 14 | 8 | 15 | 0 | April 18 | 7 | 10 | 0 | June 6 | 7 | 10 | 0 | August 10 | 7 | 15 | 0 | October 26 | 8 | 17 | 6 |
| February 14 | 8 | 12 | 6 | April 18 | 7 | 5 | 0 | June 7 | 7 | 15 | 0 | August 27 | 8 | 0 | 0 | November 16 | 8 | 5 | 0 |
| February 17 | 8 | 0 | 0 | April 19 | 7 | 0 | 0 | June 11 | 8 | 0 | 0 | September 4 | 8 | 5 | 0 | November 30 | 8 | 10 | 0 |
| February 21 | 8 | 10 | 0 | April 20 | 7 | 5 | 0 | June 18 | 7 | 12 | 6 | September 5 | 8 | 10 | 0 | December 10 | 8 | 7 | 6 |
| February 21 | 8 | 7 | 6 | May 8 | 6 | 17 | 6 | July 16 | 7 | 10 | 0 | September 13 | 9 | 0 | 0 | December 19 | 8 | 0 | 0 |

LONDON PRICES PER FLASK OF QUICKSILVER—Continued.

1889.

| DATE. | Price. | | | DATE. | Price. | | | DATE. | Price. | | | DATE. | Price. | | | DATE. | Price. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | £ | s. | d. | | £ | s. | d. | | £ | s. | d. | | £ | s. | d. | | £ | s. | d. |
| January 1 | 9 | 10 | 0 | February 6 | 8 | 0 | 0 | March 11 | 7 | 15 | 0 | May 14 | 8 | 4 | 0 | July 30 | 9 | 15 | 0 |
| January 2 | 8 | 10 | 0 | February 6 | 7 | 15 | 0 | March 11 | 7 | 12 | 0 | June 6 | 8 | 7 | 6 | September 18 | 9 | 3 | 0 |
| January 2 | 8 | 14 | 0 | February 8 | 8 | 10 | 0 | March 20 | 7 | 7 | 6 | June 6 | 8 | 15 | 0 | October 1 | 9 | 0 | 0 |
| January 4 | 8 | 15 | 0 | February 8 | 8 | 2 | 6 | March 21 | 7 | 10 | 0 | June 6 | 8 | 12 | 6 | October 5 | 9 | 0 | 0 |
| January 9 | 8 | 7 | 0 | February 8 | 8 | 0 | 0 | March 25 | 7 | 8 | 0 | June 12 | 9 | 0 | 0 | October 7 | 9 | 5 | 0 |
| January 9 | 8 | 10 | 0 | February 15 | 7 | 15 | 0 | March 25 | 7 | 10 | 0 | June 15 | 8 | 16 | 0 | October 30 | 8 | 18 | 6 |
| January 23 | 8 | 4 | 0 | March 4 | 7 | 12 | 6 | April 1 | 7 | 12 | 6 | June 19 | 9 | 5 | 0 | October 30 | 8 | 19 | 0 |
| January 23 | 8 | 5 | 0 | March 6 | 7 | 10 | 0 | April 4 | 7 | 12 | 6 | July 7 | 8 | 17 | 6 | December 2 | 9 | 10 | 0 |
| February 5 | 8 | 0 | 0 | March 6 | 7 | 10 | 0 | April 4 | 7 | 15 | 0 | July 9 | 8 | 15 | 0 | December 2 | 9 | 7 | 6 |
| February 5 | 7 | 17 | 6 | March 6 | 7 | 6 | 6 | April 10 | 8 | 0 | 0 | July 18 | 9 | 0 | 0 | December 11 | 9 | 15 | 0 |
| February 5 | 7 | 12 | 6 | March 9 | 9 | 7 | 0 | May 9 | 8 | 5 | 0 | July 23 | 9 | 5 | 0 | December 16 | 9 | 10 | 0 |
| February 6 | 7 | 10 | 0 | March 11 | 7 | 10 | 0 | May 9 | 8 | 10 | 0 | July 23 | 9 | 10 | 0 | | | | |

## ENGLISH SHIPMENTS OF QUICKSILVER TO THE UNITED STATES.

The following table shows the shipments of quicksilver from Great Britain to the United States for the years 1880 to 1889, inclusive, by months:

SHIPMENTS OF QUICKSILVER FROM GREAT BRITAIN TO THE UNITED STATES.

[Flasks.]

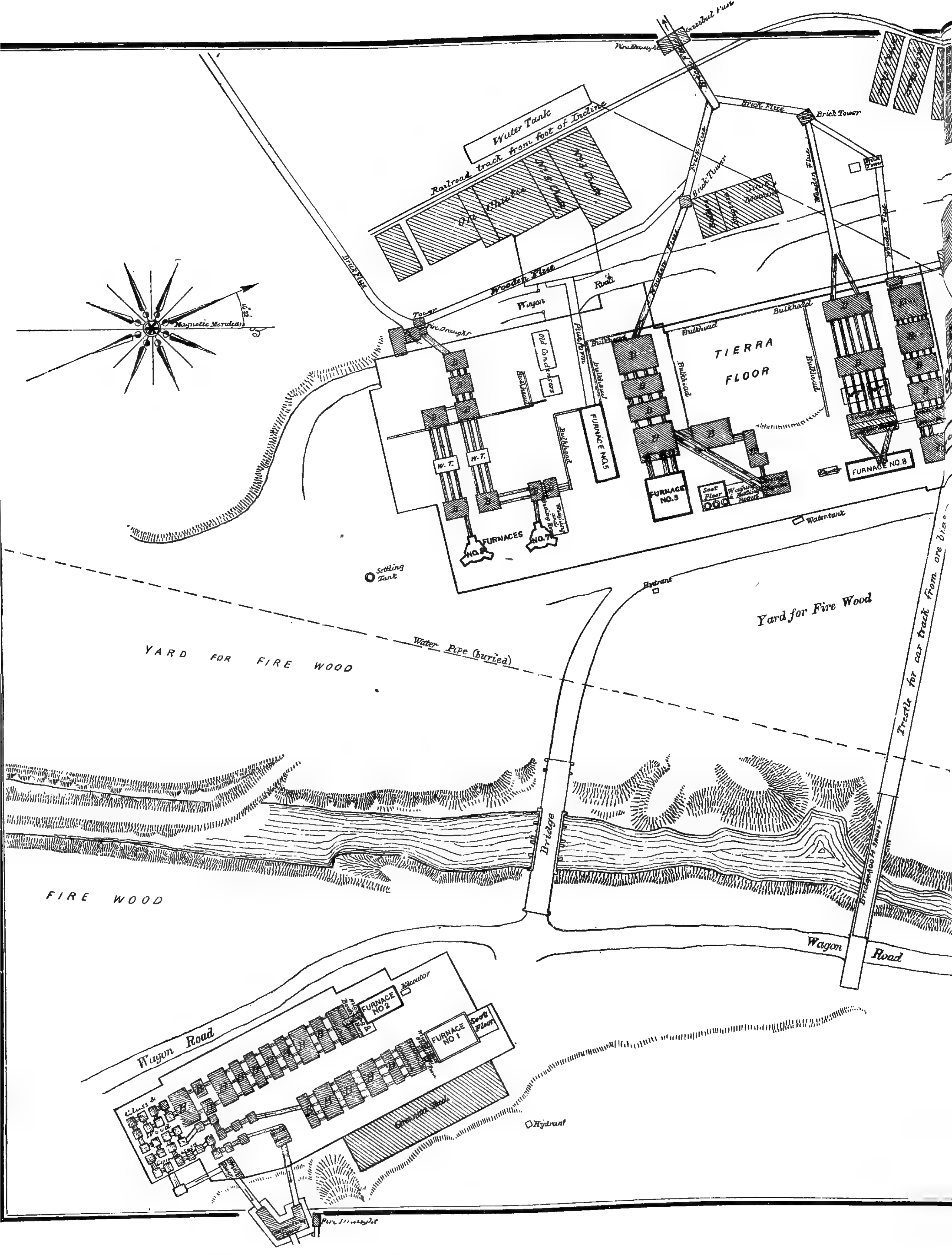
| MONTHS. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. | 1886. | 1887. | 1888. | 1889. |
|---|---|---|---|---|---|---|---|---|---|---|
| Total | 200 | 4,659 | 13,116 | 14,382 | 4,871 | 5,112 | 12,311 | 10,554 | 4,649 | 7,967 |
| January | | | 150 | 2,207 | 200 | 150 | 300 | 1,050 | 100 | 629 |
| February | | 178 | 354 | 1,753 | 200 | 350 | 156 | 300 | 600 | 500 |
| March | | 200 | 981 | 2,006 | 600 | 300 | 1,012 | 100 | | 650 |
| April | | 200 | 984 | 2,449 | 196 | 500 | 1,338 | 2,328 | 300 | 851 |
| May | | 850 | 540 | 2,067 | 500 | 100 | 1,778 | 650 | 1,899 | 1,500 |
| June | 100 | 650 | 1,772 | 2,500 | 1,254 | 500 | 700 | 2,000 | 400 | 503 |
| July | | 301 | 786 | | 21 | | 1,114 | 1,800 | 450 | 481 |
| August | | 300 | 1,714 | 300 | 450 | 500 | 999 | 910 | 150 | 450 |
| September | | 106 | 763 | 400 | 500 | 1,854 | 2,607 | 350 | | 100 |
| October | | 220 | 1,462 | 200 | 450 | 200 | 701 | 420 | | 1,550 |
| November | | 978 | 2,074 | 300 | 300 | | 805 | 646 | | 103 |
| December | 100 | 676 | 1,536 | 200 | 200 | 658 | 801 | | 750 | 650 |

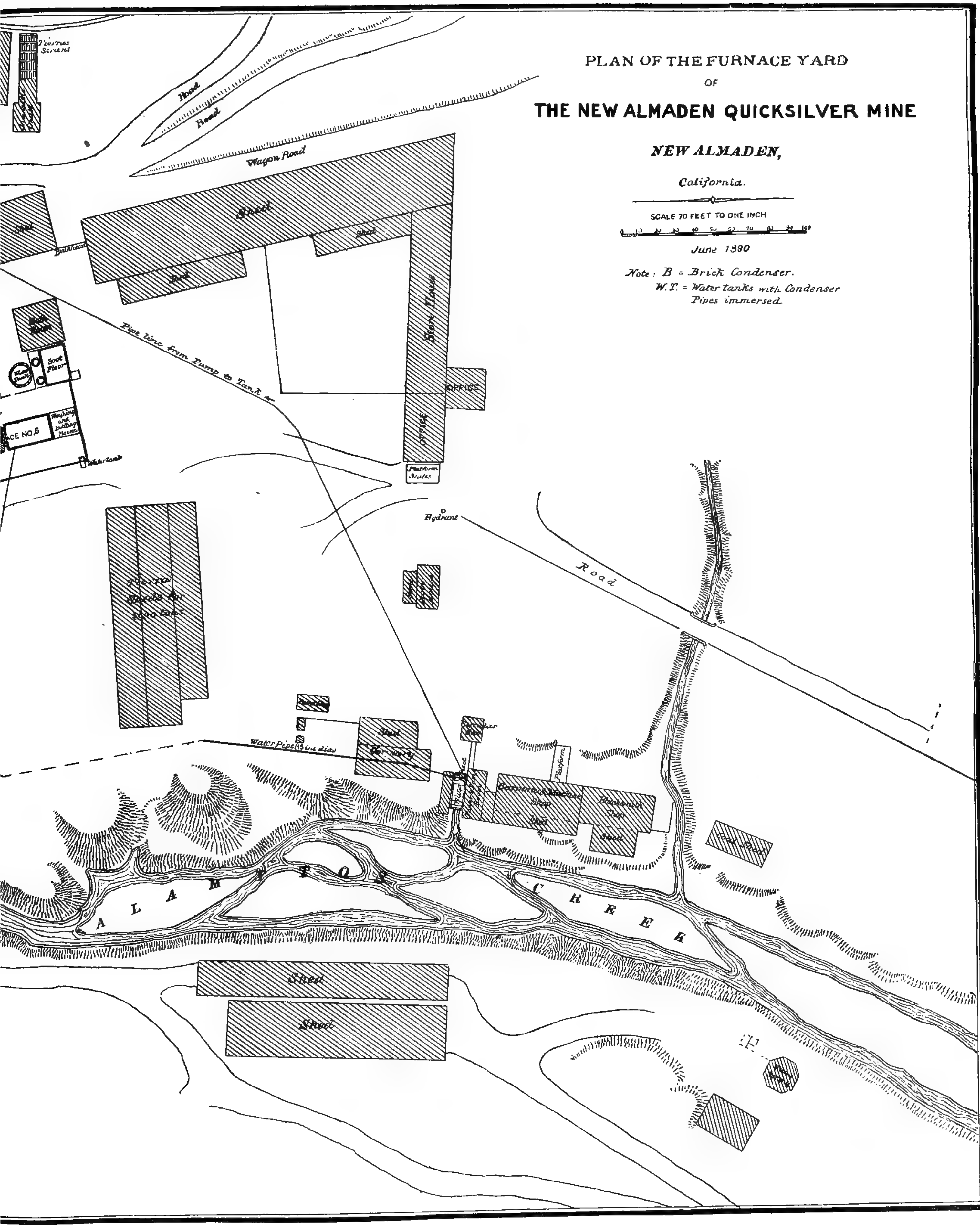
## THE NEW ALMADEN QUICKSILVER MINES.

The characteristics of the quicksilver mining industry in the United States can best be understood by the following study of the New Almaden mines:

### LOCATION.

The quicksilver deposits exploited by the Quicksilver Mining Company are situated in Santa Clara county, California, in a low range of hills, which has a general northwest and southeast direction, and culminates in Mine Hill at the elevation of 1,755 feet above sea level. This range of hills lies parallel and in front of the main coast range of mountains, separated from it by Capitancillos creek and its affluent in the western and by a branch of Alamitos creek in their eastern position. A low transverse ridge, or so-called "divide", separates Alamitos from Capitancillos creek, and connects the Mine Hill ridge with the main coast range. The highest point of the coast range is Mount Bache, situated about 5 miles south of Mine Hill, with an elevation of 3,790 feet above sea level. Mount Umunhum, 3,430 feet high, in the same range, is about southwest of Mine Hill and 3 miles distant, and Mount Chisnantuck, about 3 miles southeast of Mine Hill, is about 1,790 feet high, being the highest point in the range of hills which extends almost northerly from Mount Bache, and is separated from Mine Hill ridge by Alamitos creek with its source on the northern slope of Mount Bache. The city hall at San José is nearly 12 miles distant in a straight line from summit of Mine Hill, in the direction of north 18° west. The northerly slopes of the Mine Hill range descend gradually into the valley of Santa Clara, of which they form the southern rim. The hills are mostly covered with brush and several species of oak on the northern slope, while the southern slopes are more open. The soil is ill-adapted for cultivation, as it forms only a thin layer on the surface. Water is scarce, the Alamitos and Capitancillos creeks dwindling down in summer time to meager streams that disappear entirely at their entrance in the valley, while during the rainy season they form torrential streams. The railroad station Almaden is 438 feet above sea level, according to the railroad surveys, and the office at the hacienda about 500 feet. The climate is moderate both in winter and summer.


Fire Draught
Brick Flue
Water Tank
Railroad track from foot of Incline
Ore Chutes
No 5 Chute
No 3 Chute
Brick Flue
Brick Tower
Brick Flue
Brick Tower
Brick Tower
Wooden Flue
Wooden Flue
Wooden Flue
Wooden Flue
Brick Flue
Magnetic Meridian
Tower
Fire Draught
Wagon
Road
Platform
Old Condensers
Bulkhead
Bulkhead
Bulkhead
Bulkhead
Bulkhead
Bulkhead
Bulkhead
Bulkhead
TIERRA
FLOOR
FURNACE NO.5
FURNACE NO.3
FURNACE NO.8
W. T.
W. T.
B
FURNACES
NO.7
Weighing Room
Soot Floor
Washing & Bathing Room
Water tank
Settling Tank
Hydrant
Yard for Fire Wood
YARD FOR FIRE WOOD
Water Pipe (buried)
Trestle for car track from ore bins
Bridge
Bridge (100 ft. span)
FIRE WOOD
Wagon Road
Wagon Road
Elevator
FURNACE NO 2
FURNACE NO 1
Soot Floor
Class & Wood Condensers
Hydrant
Fire Draught


PLAN OF THE FURNACE YARD
OF
THE NEW ALMADEN QUICKSILVER MINE
NEW ALMADEN,
California.
SCALE 70 FEET TO ONE INCH
0 10 20 30 40 50 60 70 80 90 100
June 1890
Note: B = Brick Condenser.
W.T. = Water tanks with Condenser Pipes immersed.
Screens
Road
Road
Wagon Road
Shed
Shed
Shed
Shed
Bulkhead
Store House
OFFICE
OFFICE
Platform Scales
Pipe line from Pump to Tank
Soot Floor
Water Tank
CE NO.6
Weighing and Building Room
Water tank
Hydrant
Road
Sheds for 1000 tons
Water Pipe (15 ins dia.)
Shed
Platform
Carpenter & Machine Shop
Shed
Blacksmith Shop
Shed
Shed
ALAMITOS CREEK
Shed
Shed

### GEOLOGY. [a]

The New Almaden, Enriquita, and Guadalupe mines lie nearly south of San José, on spurs of the Santa Cruz mountains. This district has been much more productive in quicksilver than any other in North America, and since 1850 it has yielded four-fifths as much metal as the Almaden mine of Spain. Of special interest in the general geology of the district is the occurrence of a rhyolite dike nearly parallel to the line connecting the New Almaden and the Guadalupe. This is the only known mass of rhyolite in the coast ranges.

The greater part of the surface is occupied by metamorphic rocks, which have been determined as neocomian. They are, for the most part, identical with those so prevalent in the coast ranges. There are also masses of limestone. The general structure of the ridges of the metamorphic rock seems to be synclinal. The underlying rock of the region of New Almaden is undoubtedly granite, although it is at considerable depth.

Pebbles of olivine gabbro are found at various points in the district, but this rock has not been found in place. Upon the metamorphic rocks lie uncomformably areas of miocene sandstones. These are soft, yellowish strata, which were sharply folded by a postmiocene upheaval.

Of special importance in relation to the ore deposits is the rhyolite dike. It not only proves the former existence of volcanic activity, but emphasizes a fundamental structural axis. Parallel to this axis are the directions along which compression and upheaval took place in the early cretaceous, and folding of the tertiary rocks occurred at the close of the miocene. The age of the dike is certainly postmiocene, and probably postpliocene. The fissure system of the mines conforms in general direction with that of the dike, and it is probable that their formation is contemporaneous; also, that ore deposition took place at no great interval after the eruption of rhyolite.

### MINE MINERALS AND ROCKS.

The ore is cinnabar, sometimes accompanied by native mercury. The associated minerals are pyrite, marcasite, and chalcopyrite. The gangue minerals are dolomite, calcite, quartz, and bituminous matter, the first being more prevalent here than in most quicksilver districts—a fact probably not unconnected with the unusual quantity of limestone in the sedimentary rocks. A small amount of chalcedony and opal, usually black in color, accompanies the deposits. The rocks associated with cinnabar in this district include every variety of the metamorphic series. Where the rock happens to be a permeable sandstone impregnations have resulted. Elsewhere the ore seems to occur exclusively in crevices in the rock, many of which are only partially filled. In some cases quartz, reddened throughout by cinnabar, occurs in this manner. There is no indication that ore has been deposited by substitution, or that the rock has influenced the deposition of ore by its chemical properties. Ore is found with nearly equal frequency in contact with various rocks, and the existence of fissures appears to have been the necessary and sufficient condition for the deposition of cinnabar and gangue minerals. Where disturbances of the country resulted in the formation of open fissures, or of ground presenting a large amount of interstitial space, ore bodies were formed; but where the rock yielded to a stress as a plastic mass no room was left for ore.

### ORE DEPOSITS.

The commonest type of the ore deposits is the reticulated mass or stock work, consisting of irregular bodies of broken rock into which solutions of cinnabar and gangue minerals have filtered, cementing the fragments together with ore; clean cut fissures filled with ore may be seen, and these can only be classed as veins, though they are not persistent.

The ore in the New Almaden mine seems never to occur except close to evidences of faulting. This evidence consists in the presence of layers of attrition products, so-called clays, full of slickensides, and of fragments of rocks more or less rounded by attrition. These layers of clay usually occur on the hanging side of deposits, and are known to the miners as "altas", the Spanish term for "hanging walls". The clays are impermeable to solutions and the ore usually forms on their lower side, as if the cinnabar had ascended and had been arrested by the altas. That the solutions really took this course is clearly shown by the phenomena of other quicksilver districts as well as by the relations observed in the New Almaden mine. The miners very properly follow seams of alta in their search for ore. Sometimes, however, a second mass of ore exists on the hanging side of the clay, and is again limited by a second layer of alta. Such occurrences are to be expected in a country so irregularly disturbed as this. The alta is not a definite substance, though it is usually a dark or black mass readily distinguished even in hand specimens from the country rock. It is simply triturated country rock, and varies in composition with the material from which it has been produced. Its black color is in part due to the presence of manganese. The evidence of moving in the New Almaden mine is not confined to clays. Where the opposing walls were so nearly parallel that no considerable quantity of trituration took place, polishing occurred, and some of the slickensides met with are as brilliantly polished as if the work had been done by a lapidary.

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[a] This article and the following under the headings of "Mine minerals and rocks", "Ore deposits", and "Fissure system" are short abstracts of the article, "Descriptive geology of the New Almaden district", in Mr. George F. Becker's monograph on the geology of the quicksilver deposits of the Pacific slope.

### FISSURE SYSTEM.

The various ore bodies of the mines are arranged in subordination to a general fissure which stands in close relation to the general geology of the district. The fissures are the result of a widespread disturbance, and the direction of their strike, southeast and southwest, coincides with the direction of the fundamental axis of the disturbance. The workings in the main portion of the New Almaden mine have developed two principal fissures, dipping north. One of these dips from the surface at a high angle, and in a nearly straight line. The other strikes in nearly the same direction as the first, dips steeply from the surface, then flattens and approaches the first fissure rapidly, and in the lower workings almost coincides with the first. The first fissure contains the ore bodies east of the Randol shaft, which are continuous from the 800-foot to the 1,900-foot level; also the ore bodies west of the shaft in the hanging wall side of the other fissure, which have been worked from the 1,400-foot to the 2,000-foot level. The second fissure contains the continuous ore chute, which extends from the summit of Mine Hill toward the Santa Isabel shaft down to the 2,000-foot level.

The ore deposits of the Cora Blanca and Washington shafts have no connection with those of the main mine. In the former ore has been traced to a depth of 750 feet below the summit of Mine Hill, and in the latter to a depth of 850 feet. The Cora Blanca deposit has a strike of north 18° west, magnetic, and has a dip of 40° to the east. The strike of the Washington deposit is about north 55° west.

The ore-bearing ground of the Enriquita mine was about 500 feet in length, and had an extreme width of about 60 feet, the dip being nearly vertical. The ore was found in rich pockets in limestone, which was inclosed on both sides by serpentine.

Besides the mines mentioned, there are a number of abandoned ones, none of which was ever very productive or very extensively developed.

All the deposits of the district appear to occur along a rather simple fissure system. The main fissure is nearly parallel to the rhyolite dike at the Guadalupe mine. It follows the direction of the hills, the axis of which curves gradually away from the dike for a certain distance. Passing through or near the San Antonio and Enriquita, it seems to break across the ridge at the America and enters the Almaden on the strike of its great fissure. The Washington seems to be on a branch of the main fissure.

### HISTORY OF THE MINES AND REDUCTION WORKS.

Andres Castillero, a Mexican captain of cavalry, was sent by his government in October, 1845, to California to confer with General Sutter for the purchase of his fort, established in what is now Sacramento county. Having arrived at Monterey, he began his land journey about the middle of October, 1845. Being informed that a valuable mine existed in the hills some leagues south of Santa Clara, he went there to inspect the mine, which was then known as Chaboya's mine(*a*). Castillero, having some knowledge of assaying, tested the mineral, which he thought contained some gold and silver and a very small percentage of quicksilver. This last metal he considered then of little importance. On November 22, 1845, he made the "denouncement" of the mine before the alcalde of Santa Clara, naming the mine Santa Clara, in which he claimed to have discovered a vein of silver with an alloy of gold, being situated on the rancho pertaining to José Reyes Bereyessa.

On December 3, 1845, he again appeared before the same alcalde and stated that on opening the mine which he had previously denounced in his court he had, besides silver with an alloy of gold, also taken out liquid quicksilver, and on December 30, 1845, Antonio Maria Pico, the alcalde, gave Castillero judicial possession of the mine, to be known as Santa Clara.

Castillero associated with him in this enterprise Don José Castro, then commanding general of the Mexican forces at Monterey, Secundino and Teodoro Robles, and the father friar José Maria del Refugio Suarez del Real, and went with the last named to the mine to begin operations in December, 1845. Castillero and Padre Real employed William G. Chard, a native of New York, to open the mine. Having no retorts of any kind, Chard put the ore in gun barrels, the mouths of which he placed in water, and, heating the barrels over a fire, distilled some metal. This process, however, was soon abandoned for a better one. A hole or well was dug in the ground and a trough full of water was placed in the bottom. Bars of iron were laid across the top of the well, and a copper still with the upper part coming up through the bars reached down into the water. Ore was then piled on the bars, and a whaler's trying pot was reversed over the heaped ore, wood piled around the pot and over it, and then set on fire. The mercury vapors were forced through the pipe into the water by the heat. In this primitive way from 3 to 4 tons of ore could be reduced with from 6 to 8 cords of wood, the operation lasting from 16 to 18 hours. As the escaping vapors made the work very dangerous, Padre Real conceived the idea of building a new furnace. This was made of adobes, 10 feet high and about 8 feet in diameter on the outside, with 2 chambers inside, one above the other. The top of the lower chamber, which was used as the fireplace, was made full of holes, through which the flames could pass into

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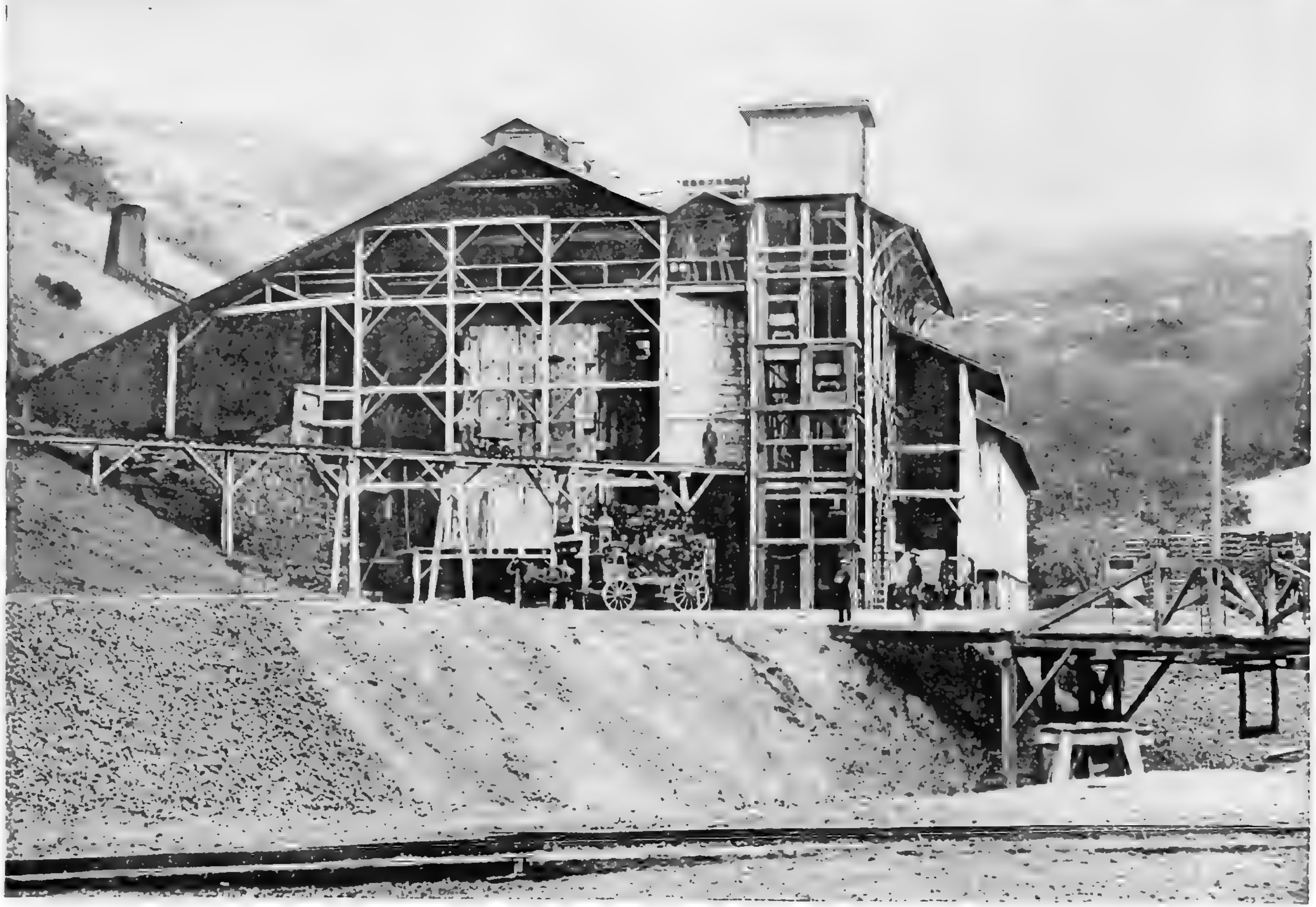
[a] It is also stated that the mine had been known long before this time, and that Antonio Suñol, Luis Chaboya, and an old man named Robles first discovered and worked the mine as early as 1824, and that to work the ore a mill had been built by Chaboya on the creek now called Alamitos. It is also said that the Indians came to the mine to get paint, which they called "pooyi"



QUICKSILVER FURNACES Nos. 1 AND 2, 1889, NEW ALMADEN, CALIFORNIA.

the upper chamber that was filled with ore. The upper chamber had a large hole on top for charging it with ore. This hole was closed by an iron door during the operation of firing, and cemented, and 6 or 8 iron pipes led the vapors from the upper chamber into a water tank (evidently a copy of the Bustamente furnace without the aludels). This furnace, built only of sun-dried bricks, or adobes, did not succeed very well, as it bursted when the fire became very hot, and badly salivated Chard and the men working at it. It was therefore charged only once.

Castillero had returned to Mexico early in 1846 to report the result of his mission, and while there appealed to the Mexican government for aid in his mining enterprise, in which he succeeded. A contract was made with him in the City of Mexico in May, 1846, by which the government agreed to advance to Castillero and his associates the sum of $5,000 and give other aid for the development of the mine. Unluckily for Castillero, the difficulties just then broke out between the United States and the Mexican government, which ended in the cession of California, and the Mexican government, foreseeing this danger, stopped the payment of the stipulated sum to Castillero. Padre Real had been left at the mine to take care of it. Left to their own resources, and not having the means to carry on the work and make the necessary improvements, Don José Castro, for himself and associates, then made a contract with the banking firm of Barron, Forbes & Co., of San Blas and Tepic, Mexico, by which the latter became lessees of the mine for 16 years, and some time after making the contract became part owners in the mine by the purchase of some of the shares. Mr. J. A. Forbes took charge of the mine for Barron, Forbes & Co. in August, 1846, possession being given by Padre Real. The new firm changed the name of the mine, calling it New Almaden.

When Forbes arrived at the mine the underground workings consisted only of an adit or horizontal entrance 20 or 25 feet in length through the rock. The quicksilver ore was in sight on either side. There was a floor or planilla on the outside of the tunnel, formed of the waste material broken from the mine. Chard, as major-domo, was in charge, assisted by a white man (a blacksmith) and several Indians. One of the Indians remained constantly at the mine to guard it, and slept in the tunnel at night. They were then not actively engaged in extracting ore, but the reduction of the ore took place at the hacienda near the creek every day, sometimes with 2 pots. The ore was brought down from the hill on mules' backs. A log house, as dwelling, and a blacksmith shop were the only buildings constructed. Forbes received from Padre Real 2,000 pounds of quicksilver that had already been distilled. (*a*)

Forbes then erected furnaces with retorts made of 4 potash kettles, built into walls of adobe, with condensers of masonry work immediately adjacent. 400 pounds of ore of average quality, broken into lumps the size of an apple, were put into each kettle or retort, the covers put on and luted with a layer of sand. The fires were then kept up till near night, when the furnaces were allowed to cool gradually. On the next morning the condensers were opened and the metal, which usually amounted to from 300 to 400 pounds from the 4 pots, dipped up. This was a much less percentage than the usual assay indicated, and it was obvious that a large portion of the metal was lost. Forbes wished to devise some way of extracting the metal without mixing lime with the ore in roasting, but was unsuccessful. At length a kiln of lime was burned, and "I am informed", says Rev. Chester S. Lyman, the surveyor, "that the ores yield with this a vastly greater percentage of metal. In the last 3 weeks about 10,000 pounds of metal have been extracted with the same apparatus, being a yield of over 50 per cent". Mr. Lyman stated that in February, 1848, while Alexander Forbes was at the mine as superintendent, there were 4 furnaces in operation for extracting quicksilver, employing from 20 to 30 men. (*b*)

Dr. Tobin arrived from England during the year 1849 to take charge of the reduction works. According to his letter in Ure's Dictionary of Arts, volume II, page 140, the mine resembled then a gigantic rabbit warren. Its greatest depth was about 150 feet, and the weekly extraction of ore varied from 100 to 150 tons. Dr. Tobin got 16 cylinders (retorts) at work, producing from 1,400 to 1,500 pounds of quicksilver daily. This result was satisfactory so far as production was concerned, but not so as regarded expense in fuel and labor. 6 furnaces of the Idria style were built by Mr. Baker, each of 1 ton capacity, and 2 more of a larger size by Dr. Tobin. Very rich ore was burned in these furnaces, but as they were badly constructed so far as the bottoms of the condensers were concerned, very large quantities of quicksilver ran through the foundations into the ground, which in later years was recovered by washings. The small Baker furnaces were built on the south side of Alamitos creek, and Tobin's furnaces on the north side. Tobin's big furnace did not last long; it burst in many places, and salivated all the workmen. It was therefore determined to build the so-called medium furnaces of about 15,000 pounds capacity.

Mr. Russell Bartlett, the United States commissioner on the Mexican and United States boundary question, who visited California in 1853, states that the quantity of quicksilver annually produced at New Almaden exceeded 1,000,000 pounds, and makes mention of 6 furnaces that were kept going night and day. 7 or 8 days were required for 1 furnace operation; that is, charging, firing, and discharging. The men working at the furnaces were so much affected by the escaping vapors that they were kept at the work for 3 or 4 weeks only, when a fresh set of workmen were put in their place.

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*a* Silliman's Journal: Letter of Rev. C. S. Lyman, Pueblo de San José, March 24, 1848.

*b* United States *vs.* Andres Castillero, No. 420, 1859, page 12, transcript of record.

Mr. Ruschenberger gives a more detailed account of the distilling apparatus, as follows: (*a*)

> A kind of reverberatory furnace 3 feet by 5 feet is arranged at the extremity of a series of chambers of nearly, if not exactly, the same dimensions, namely, 7 feet long, 4 feet wide, and 5 feet high. There are 8 or 10 of these chambers in each series, built of brick, plastered inside, and secured by iron rods, armed at the ends with screws and nuts as a protection against the expansion by heat. The tops are of boiler iron, luted with ashes and salt. The first chamber is for a wood fire, the second is the ore chamber, which is separated from the first by a network partition of brick. The flame of the fire passes through the square holes of this partition, and plays upon the ore in the ore chamber, which when fully charged contains 10,000 pounds (5 tons) of cinnabar. Next to the ore chamber is the first condensing chamber, which communicates with it by a square hole at the left lower corner. An opening at the right upper corner of the partition between the second and third condensing chambers communicates with the latter. The openings between the chambers are at the top and to the right and at the bottom and to the left alternately, so that the vapors from the ore chambers are forced to describe a spiral in their passage through the 8 condensers. The vapor and smoke pass from the last condensing chamber through a square wooden box, 8 or 10 feet long, in which there is a continuous shower of cold water, and finally escape into the open air by tall wooden flues. The floor or bottom of each condensing chamber is about 2 feet above the ground, and is arranged with gutters for collecting the condensed mercury and conveying it into an open conduit, along which it flows into an iron receptacle, from which it is poured into the iron flasks. There are 14 of these furnaces and ranges of condensers, with passages of 8 or 10 feet in width between them. A shed is constructed above the whole at a sufficient elevation to permit free circulation of the air.

The firing was kept up for 60 hours, and the furnaces required 48 hours for cooling before they could be discharged. The fine ores were mixed with clay and water and made into bricks called "adobes", size 10 inches by 4.5 by 4.5 inches, dried in the sun. The larger pieces of ore and adobe were then piled up in the ore chamber, which, when fully charged, contained about 5 tons of ore. This style of furnace remained in operation during the following years, the only modifications made being the size, which was considerably increased.

In 1863, when the Quicksilver Mining Company took possession of the property, there were 5 intermittent furnaces at the hacienda, while a new furnace, No. 6, was completed in December, 1864, with a capacity of 84 tons.

| NUMBER OF FURNACE. | When first put in operation. | Capacity. (Short tons.) |
|---|---|---|
| 1 | July, 1861 | 40 |
| 2 | May, 1862 | 40 |
| 3 | November, 1862 | 40 |
| 4 | September, 1863 | 40 |
| 5 | May, 1864 | 40 |

Furnace No. 1 was the only one built without iron plates in its foundation, while all the other furnaces were so provided.

The subsequent improvements in the furnace plant were as follows:

In 1873 the first shaft furnace continuous in operation was built, after the Page patent, on the site of old furnace No. 2, which was removed for this purpose.

Furnace No. 5 (*b*) received an addition to its condensation plant by the erection of 2 iron condensers of the Fiedler patent.

Furnace No. 6 (*b*) had a wooden condenser added, 26 feet in length, 14 feet in width, and 20 feet high, containing 6 chambers of equal size. The result of this addition was very gratifying, as was found by the examination of the flue, which formerly had yielded from 60 to 100 flasks of quicksilver annually and only 2 flasks after the new condensers went into operation. The flue was also extended a distance of 100 feet and a new smokestack erected.

Furnace No. 7 (*b*), having been unserviceable for 3 years was torn down, with its first 3 condensers.

Furnace No. 1 had then 17 condensing chambers; No. 2 18 condensing chambers; Nos. 3 and 4 combined 39 condensing chambers; No. 5 20 condensing chambers, besides 2 Fiedler condensers, and No. 6 20 brick condensing chambers and 6 wooden chambers.

Another improvement with advantageous results was the introduction of openings (covered with glass) into all the upper part of the brick and wooden condensers, allowing the outer and cooler air to come more easily in contact with the hot fumes, as the thickness of a thin pane of glass only intervened, which insured a more rapid and thorough condensation. Trials were also made during 1873 to introduce the combustible with the ore. Coal, coke, and charcoal were first used, but later only coke and charcoal, as the use of coal was not considered beneficial. It was considered that this process would be advantageous in burning and roasting the ore more perfectly and rapidly, especially in places where the flame from the wood fire of the fireplace could not reach freely.

In 1874 the continuous shaft furnace No. 2, built in the previous year according to the Page patent, not proving as beneficial as anticipated, the discharge of ore being irregular, was partially razed and rebuilt into an improved, old style intermittent furnace, and exclusively used for the burning of adobes, with a capacity of 111,000 pounds of adobes per charge, or 444,000 pounds per month. The condensing chambers of this furnace, which were the same as originally used for the old furnace, consisting of a solid block of 18 chambers, were divided into 2 blocks by cutting out one of the chambers and thereby obtaining a better circulation of air, not only on the outside walls but also through the lower arches and passageways on which these condensers are built. The subject of a more economical and improved method of reduction and condensation was the object of constant study and experiment,

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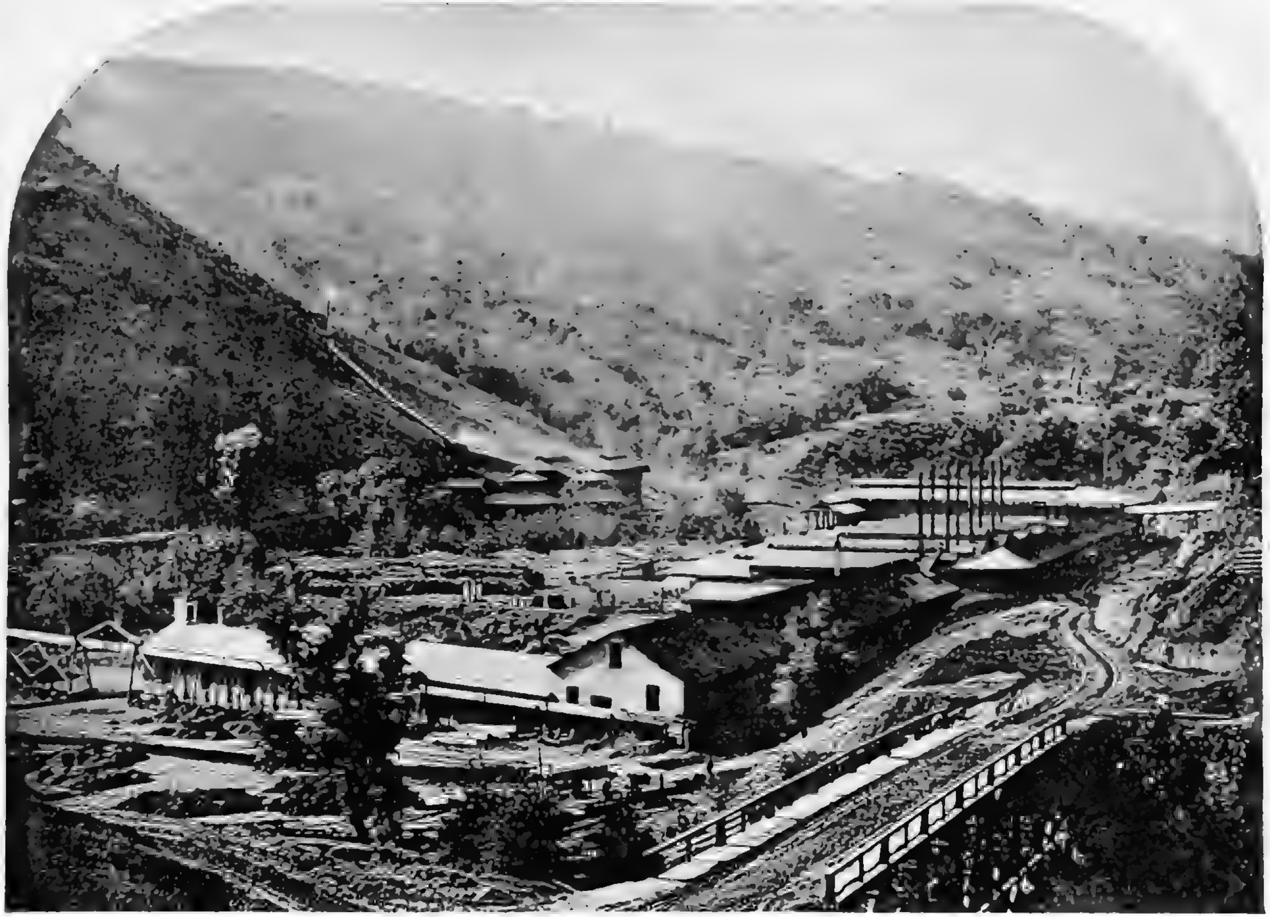
[a] Ure's Dictionary of Art, supplement, page 743.

[b] Built prior to 1870, and intermittent.



NEW ALMADEN—THE REDUCTION WORKS, OR "HACIENDA", IN 1870.

and the results are evidenced by the introduction of the new iron condensers of the Fiedler patent and those made of wood and glass of the Randol & Fiedler patent, also the introduction of the improved method of extracting quicksilver from the soot by the Randol & Wright process. 4 wood and glass condensers of the new style were built for furnace No. 5, each being 22 feet long, 8 feet wide, and 15 feet high, a cast-iron condenser of the Fiedler type being also added. A wooden tower, with an upcast and downcast shaft, was erected for furnaces Nos. 1 and 2, in the rear of the last condenser, the downcast shaft being supplied from the top with a spray of water which fell through a series of triangular wooden cross-pieces inserted into the sides of the shaft in alternate opposite directions, which divided the water into minute particles, intended to combine with the fumes from the condensers, in order to precipitate all the metallic content reaching this point.

Furnace No. 7, ironclad, of the continuous type, nearly alike to those in operation at the Idria mine in Austria, was also commenced in 1874 and finished in 1875. 2 brick towers and 2 large brick condensers were added to the plant of this furnace. From these the fumes were made to pass through the condensers of furnace No. 5 (not then in operation), and thence into the 4 new wood and glass condensers above mentioned. As this left furnace No. 5 with only 2 iron condensers, a new series of condensers were built for the latter furnace, of which 2 were of brick and 3 of wood and glass, the last ones being each 12 feet long, 12 feet wide, and 20 feet high, with 34 large windows, each condenser being divided into 4 chambers. A new flume 1,000 feet in length, made of Oregon pine and leading to a central chimney, was also built, which received all the fumes from furnaces Nos. 3, 4, and 6. The old brick condensers were provided with new openings, closed in by windows of glass or iron, for better cooling the vapors.

In 1875 the flue began in 1874 was completed and proved of much benefit by carrying the smoke away from the hacienda. Another wood and glass condenser, 12 feet square and 20 feet high, made into 4 compartments and provided with 34 large windows, was added to the plant of furnace No. 5. Furnace No. 7 received the addition of 2 brick towers to its condensation plant, each 7.5 feet wide, 12 feet long, and 26 feet high; also 2 brick condensers, one 27 feet long, 10.5 feet wide, and 27 feet high, and the other 20 feet long, 20 feet wide, and 10 feet high. Furnace No. 1 received the addition of another large wooden condenser built on the same plan as those for furnace No. 5. The wooden tower erected in 1874 for furnaces Nos. 1 and 2 and provided with water spray was removed, as it was found to operate badly. To give additional condensing space to furnaces Nos. 1 and 2 a large brick tower was erected on the adjacent hillside and connected by wooden flues with the last condensers of these furnaces, whence the smoke passes into the main flue that leads up the mountain side to the chimney. The brick chimney serving as outlet to furnaces Nos. 5 and 7 was raised a further height of 32 feet, altogether 62 feet, to increase its draft. 2 Fiedler iron condensers were added to the condensing plant of furnace No. 6 and connected with a Root blower, driven by a small steam engine, to withdraw from the furnace any mercurial vapors remaining after firing had ceased (the furnace being intermittent). Foundation was laid at the end of December, 1875, for another ironclad furnace, No. 9, similar to No. 7 (*a*), in successful operation. Experiments were made with the object of constructing a continuous furnace for the burning of tierras without making them into adobes, and No. 5 furnace was changed into a trial furnace for this purpose, and worked so satisfactorily that plans were made for the double continuous furnace, No. 8 (*b*). The construction of the additional condensers, wherever found necessary, during the past 2 years had given very good results, and scarcely any quicksilver was found in the flues leading away from the last condensers, and in the whole aggregate length of these flues of 1,643 feet (leaving out joint flue of Nos. 5 and 7 furnaces, as both furnaces were in operation and are continuous in action) only 6 flasks of quicksilver were collected after a run of 16 months' operation.

The 2 ironclad continuous furnaces, No. 9, for granza or coarse ore, and No. 8, for tierras or fine ore, were completed and put in operation during the year 1876. It is interesting to show the cost and profit of working the continuous tierras furnace, based on actual work for 39 days and giving 1.40 per cent yield of quicksilver:

| | |
|---|---|
| Cost of tierras at the mine and dumps, 10 cents per carga, or per ton | $0.67 |
| Cost of transportation | 0.35 |
| Total cost of tierras | 1.02 |
| One day's supply for No. 8 furnace, 24 tons, at $1.02 per ton | $24.48 |
| Labor of 5 men in 24 hours | 12.00 |
| Fuel, 2.57 cords wood, at $6 per cord | 15.42 |
| Flasks | 9.00 |
| Total cost, $7.766 per flask, or | 60.90 |
| Estimated daily yield, 9 flasks of quicksilver, at 50 cents per pound | 344.25 |
| Daily profit | 283.35 |

As the furnace is expected to run at least 300 days in the year, the annual profit would be $85,000 from this furnace alone. The dumps and old workings of the mine contained a large amount of tierras that could be profitably worked in this new furnace. Of the old style intermittent furnaces No. 6 was the most favorable exponent, giving the best results for labor and fuel. In 1876 the average cost of working ores in it was $1.97 per ton, of which 63

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[a] Continuous furnace of Exeli type.

[b] Tierra furnace, Huttner & Scott patent.

cents was for furnace labor and $1.34 for fuel. To roast tierras in the intermittent furnaces it was necessary to first make them into adobes, at a cost of 95 cents per ton for making and handling.

With this data the cost of roasting all the ores handled in 1876 can be arrived at if the work had been done in the old style furnace under the most favorable circumstances:

| | |
|---|---|
| The coarse ores roasted were 7,392 tons, at $1.97 per ton | $14,562.24 |
| 9,266 tons tierras cost $1.97 per ton roasting and 95 cents per ton making into adobes and handling, together $2.92 per ton | 27,056.72 |
| Total cost of 16,658 tons for labor and fuel, $2.4985 per ton | 41,618.96 |

Now, the ironclad continuous furnaces Nos. 7 and 9 roasted coarse ore at a cost of $1.1833 per ton, of which there is for furnace labor 52 cents and fuel 66.33 cents; the continuous tierras furnace No. 8 works tierras without making into adobes at a cost of $1.1425 per ton, 50 cents being for labor and 64.25 cents for fuel. The cost would therefore be as follows:

| | |
|---|---|
| 7,392 tons coarse ore roasted in improved furnaces (continuous), at $1.1833 per ton | $8,747.20 |
| 9,266 tons tierras not made into adobes but roasted in new continuous furnace, at $1.1425 per ton | 10,586.40 |
| Total cost of 16,658 tons for labor and fuel, at $1.1606 per ton | 19,333.60 |
| The year's work in old furnaces cost | 41,618.96 |
| The year's work in new furnaces cost | 19,333.60 |
| In favor of new furnaces, 53.54 per cent | 22,285.36 |
| Cost per ton, old furnaces | 2.4985 |
| Cost per ton, new furnaces | 1.1606 |
| Decrease, 53.54 per cent | 1.3379 |

The first 3 condensing chambers of No. 6 furnace were taken down and in their place a new condenser with drying chamber for moist tierras was erected. The first block of condensers of furnace No. 5 was covered on top with iron plates to form a drying floor for moist tierras. The ironclad furnace No. 9 was completed in April, and was started on May 13. 2 brick condensers and 2 wood and glass condensers were erected for this furnace and connected with the four similar condensers formerly belonging to No. 5.

For a period of 4 months continuous operation of the 2 ironclad shaft furnaces, Nos. 7 and 9, it was found that the amount of ore burned was:

| | POUNDS. |
|---|---|
| Granza | 3,113,600 |
| Terrero | 1,571,200 |
| Total | 4,684,800 |

or 2,342.4 tons.

The expenses were:

| | |
|---|---|
| For labor | $1,220.00 |
| For 182.75 cords of wood, at $6 per cord | 1,096.50 |
| For 70,272 pounds of coke, at $13 per ton | 456.76 |
| Total | 2,773.26 |

The furnaces during this time yielded 6,382 flasks of quicksilver, with the following result:

| | |
|---|---|
| Cost of labor per flask | $0.190 |
| Cost of wood | 0.172 |
| Cost of coke | 0.072 |
| Total cost per flask | 0.434 |

The new ironclad tierras, furnace No. 8, Huttner & Scott patent, was completed in October and started November 1, 1876. This furnace roasts 24 tons of tierras in 24 hours. It has two brick condensers covered and joined by iron plates, which serve as a drying floor for tierras, 2 iron condensers, and 7 condensers of wood and glass. The furnace itself is 46 feet high, 10 feet wide, and 38 feet long.

In 1877 a large bathhouse was built for the men working at furnaces. A new brick flue was built for furnaces Nos. 3, 4, 6, and 8, and a brick chimney was added 81 feet high. The cornerstone was laid on August 25, 1877, for a new granzita and tierras furnace, No. 3, of the Huttner & Scott type, on the site of old intermittent furnace No. 3, which was torn down.

Comparing the results from No. 8 furnace with assays of samples taken from each car of tierras before charging the furnace, it was found that during the months of November and December, 1876, and January, February, March, and April, 1877, this furnace roasted 5,278,000 pounds of tierras, the actual yield of which amounted to 81,319.5 pounds of quicksilver, while the theoretical amount according to assays indicated 87,862.5 pounds contained in the ore. This shows a loss in reduction of 6,543 pounds, or 7.45 per cent. Allowing, however, 5 per cent of the total weight of the tierras for moisture, there was only a loss of 2.58 per cent.

With the coarse ore furnaces, Nos. 7 and 9, from which assay samples could not be obtained without a great deal of trouble and additional expense, a similar calculation could not be made, but as these furnaces had each a separate system of condensers (No. 7 nearly all of brick and No. 9 of brick and the greater part of wood and glass), it was remarkable that after a continuous campaign with these furnaces for 9 months ended May 31, 1877, during which time each furnace roasted 5,241,600 pounds, the ore for both furnaces having been taken from the same ore bin, the yield of No. 7 furnace was found to have been 7,539 flasks, and that of No. 9 furnace 7,541 flasks, the difference in yield between the 2 furnaces being only 2 flasks.

Large weighing scales had been placed on the track over which the loaded cars passed, so that each charge of 1,600 pounds of ore was accurately weighed.

In February, 1878, the new ironclad furnace No. 3 was completed. On December 30 of the same year the work of furnaces Nos. 7 and 9 ended for the purpose of annual cleaning. The result was for No. 7 furnace, 716 flasks, and for No. 9, 720 flasks, a difference of 4 flasks, both furnaces having been charged with equal amounts of the same grade of ore. In furnace No. 7, however, a trial had been made of adding 240 pounds of lime to each charge, but as the furnace produced less quicksilver with the same grade of ore the addition of lime was not considered beneficial and was discontinued.

The intermittent furnace No. 2 was changed into a Huttner & Scott continuous furnace for granzita, with a daily capacity of 18 tons, and received the first charge of ore on June 20, 1879. Furnace No. 1 was pulled down and rebuilt like No. 2 furnace, with a capacity of 36 tons daily, and finished in January, 1880. The condensation plant of both furnaces was also increased at the same time by adding 14 wood and glass condensers of the latest style, each 4.5 feet square and 25 feet high, to furnace No. 2, and 21 of the same style to furnace No. 1.

During the year 1882 one Idria condenser, consisting of three cast-iron pipes, each 22 inches in diameter, standing in a tank and surrounded by cold water, was added to the condensing system of furnace No. 7. The flue leading from furnaces Nos. 7 and 9 having been also connected with the brick flue leading to the chimney for furnaces Nos. 3, 6, and 8 during the previous year, a Guibal fan, worked by a small tangent wheel driven by water under high pressure, was added to the brick flue to exhaust the smoke by strong draft. The large brick condensers of furnaces Nos. 3 and 6, and later on those of Nos. 1 and 2, were improved by cutting out every third chamber and connecting the different blocks by a system of inclined earthernware pipes. The so-called water back, consisting of a number of 4-inch tubes filled with running water and passing through one of the chambers nearest the furnace, was first tried with furnace No. 2, and gave such good results that this system of cooling the vapors was finally introduced in all the first two condensers of the different furnaces.

In the year 1882 experiments were made to burn coal, in part, with wood. These experiments gave good results with some of the furnaces, but were discontinued immediately in furnaces Nos. 7 and 9, as the small amount of coal used (300 pounds, in place of one-fourth of a cord of wood) did not generate the required heat. A set of wooden screens to aid the condensation of the vapors was introduced in one of the rear condensers of furnace No. 2, and the same arrangement added to condensers of furnace No. 3. Two new brick condensers were built in place of the wood and glass condensers for furnace No. 8, each being 10 feet wide, 29 feet long, and 30 feet high, covered on top with iron plates cooled by flowing water, and each divided into 2 chambers, the last condenser also provided with sloping zigzag screens. A water-tank condenser like that for furnace No. 7 was also added, differing only in having earthenware pipes in place of the costly iron ones. The iron roofing, being soon destroyed by the acid vapors, was replaced by thick boards, and the use of water thereon for cooling was abandoned in consequence.

The introduction in the line of condensers in 1881 and 1882 of water backs and the new style of Idria condensers, consisting of cast-iron pipes standing in a tank of cold water, also the partitioning of the larger condenser chambers, proved very effective, as demonstrated by the small amount of quicksilver obtained in the rear condensers and the proportional amount in the first condensers of the system thus fitted up. The artificial draft by the Guibal fan also worked so well that no further cases of salivation occurred. Furnace No. 9 was supplied, therefore, with a new Idria condenser like No. 7, with iron pipes and water tank, and new brick condensers containing revolving screens were added during the year 1883.

In 1885 a Guibal fan was placed in connection with furnaces Nos. 1 and 2, and the chimney flue of these furnaces was extended 270 feet farther uphill in 1887.

A detailed account of the furnaces and condensers has been published in the transactions of the American Institute of Mining Engineers, volumes XIII and XIV, from papers by Samuel B. Christy, Berkeley, California, entitled "Quicksilver reduction at New Almaden", and "Quicksilver condensation at New Almaden". A few changes have been made in the furnace work at New Almaden since the publication of these papers.

The addition of 1.5 per cent of fuel in the form of coke and charcoal to every charge of 1,600 pounds of coarse ore in furnaces Nos. 7 and 9 has been discontinued since the beginning of the year 1888, with the results that the vapors are not overheated, and, being less expansive, travel a less distance before they are condensed. The same addition of fuel to the granzita ore had been discontinued long before.

During the year 1888 an electric plant was installed at the hacienda to drive the Guibal fan for furnaces Nos. 1 and 2, which are on the east side of the creek. This plant proved so satisfactory that it was enlarged by the installment of a 16-horsepower dynamo at the Buena Vista shaft, with motors at each of the 2 Guibal fans, the connection being made by 7,000 feet of wire. The power is supplied by a small upright engine at Buena Vista shaft, resulting in a saving in fuel and labor and lessening the danger of fire at the furnace yard. Careful measurements have shown that 0.5 horse power is sufficient to drive one of the Guibal fans at a velocity of 60 to 70 revolutions per minute, which is the ordinary speed maintained when condenser cleaning is not being done and all the doors are closed. During condenser cleaning, with usually 1 condenser door open, the speed is increased to 120 revolutions, more or less, depending very much upon the state of the weather.

FURNACE PLANT AT NEW ALMADEN IN 1890.

| Number of furnace. | Continuous. | Intermittent. | STYLE. | Daily capacity in tons. | Class of ore roasted. | Number of separate brick condensers. | Total number of brick condensers. | Number of brick towers. | Number of glass and wood-towers. | Number of water-back condensers. | Number of Idria condensers (a). | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | .......... | Huttner & Scott...... | 36 | Granzita...... | 6 | 10 | 1 | 21 | 3 | .......... | Connect with one chimney. |
| 2 | 1 | .......... | ....do .............. | 18 | | 11 | 16 | 2 | 14 | 2 | .......... | |
| 3 | 1 | .......... | ....do .............. | 36 | Tierras ....... | 7 | 20 | 1 | .......... | .......... | .......... | Connect with one chimney (b). |
| 5 | 1 | .......... | ....do .............. | 20 | | 4 | 10 | .......... | .......... | .......... | .......... | |
| 6 | .......... | 1 | Old .............. | $\frac{80}{100}$ | Granza ....... | 7 | 16 | 2 | .......... | 2 | .......... | |
| 8 | 1 | .......... | Huttner & Scott...... | 24 | Tierras ....... | 4 | 8 | .......... | .......... | 2 | 2 | |
| 7 | 1 | .......... | Ironclad .............. | 10 | Granza ....... | 6 | 9 | 1 | .......... | 2 | 1 | |
| 9 | 1 | .......... | Exeli .............. | 10 | | 2 | c5 | .......... | .......... | 2 | 1 | |

a This condenser consists of iron pipes or earthen pipes cooled in a water tank.

b A connection exists also by separate brick flues to another brick chimney common only to furnaces Nos. 7 and 9.

c The second brick condenser connects with the fourth brick condenser of No. 7, both furnaces mingling their fumes at this point.

The continuous efforts made to improve the working of the soot and to replace the manual labor of stirring it on inclined planes, which was the process in use during the last few years, finally culminated in 1888 in the invention by Superintendent Von Leicht of a soot machine by which the soot is cleaned by steam power.

The apparatus consists of a cast-iron pot of nearly hemispherical shape, 3 feet 5 inches in diameter and 18 inches in depth. A perpendicular shaft passes down through the center of this vessel, the lower end of which is provided with 4 screw blades that fit exactly the inner surface of the vessel and are made only 12 inches high, the upper edge of each blade being horizontal. The shaft to which the blades are attached passes through a circular opening in the bottom of the vessel just large enough for revolving easily in it, with a play of about one-sixteenth of an inch. The vessel being filled with the soot to be cleaned (each charge contains 3 cubic feet), the shaft is made to revolve by proper overhead gearing between 30 to 50 revolutions per minute. In these revolutions the soot is scraped up by the blades and drops over the upper edge onto the next blade, and so on, keeping constantly in motion, and thus bringing the small globules of quicksilver in contact with each other, uniting them, when they flow to the center of the vessel and pass out through the hole in which the shaft revolves.

Below the soot vessel a short inclined floor is laid, over which the cleaned quicksilver runs down and passes through a gooseneck into a receiver. The soot vessel has the central part of its bottom, about 12 inches in diameter, on hinges. When the soot has been so far cleaned that only a small amount of mercury remains, the shaft is raised, the hinged bottom is opened, and the soot dropped on the inclined floor, from which it is easily taken up by shovels and placed in buckets to be brought back to the furnace from which it originally came. A portion of it is added to every charge of ore, in order to be burned again.

This soot machine requires about 3 horse power, with a speed of from 30 to 50 revolutions. A charge of soot remains about 1.5 hours. The room in which this machine is set up is well ventilated, and the man who attends to all of the work connected with it, that is, keeping up steam, charging and discharging the soot, flasking the quicksilver, etc., is not exposed to any noxious vapors. From June 1, 1888, to September 30, 1889, there were produced in the cleaning of the various condensers 8,191 buckets of soot, to which were added 1,226 buckets of ashes, making a total of 9,417 buckets, or about 4,708.5 cubic feet of soot and ashes worked by the soot machine, from which were obtained 175,969 pounds of quicksilver, or 2,300 flasks and 19 pounds. The total production of quicksilver at the reduction works during these 16 months was 18,346 flasks, from which it will be seen that the percentage of quicksilver cleaned by the soot machine was 12.54 of the total amount of quicksilver produced. The total expenses of condenser cleaning and working of the soot machines during these 16 months was $1,764.15, which gives 1 cent as the average cost per pound of quicksilver obtained from soot. In this estimate the cost of fuel for steam is not included.

Other improvements made include the setting up of a machine for threading flasks and stoppers at the hacienda machine shop in 1886, by which, if necessary, 100 flasks per day can be handled, and old flasks are made serviceable. In 1887 the inclined flue from furnaces Nos. 1 and 2 was extended 270 feet farther up the slope of the adjoining hill, which added much to the general comfort by carrying the smoke to a higher altitude. In 1888 a new water tank of 3,750 cubic feet capacity was erected at an elevation sufficient to provide all the balance hoists with the necessary water, and in 1889 a pump was set up at the water wheel, by which it is worked, pumping water at night, thereby economizing expense for pumping. In 1888 experiments were made with fuel oil as combustible for the furnaces, but the results were unsatisfactory.

The accompanying drawing shows in detail the plan of the present plant at the New Almaden reduction works.

### TRANSPORTATION FACILITIES.

A county road leads from the hacienda to San Jose, a distance of 12 miles. The Southern Pacific Company has 2 railroad branches terminating within 2 miles of the hacienda. The Almaden line of the South Pacific Coast Railway division (narrow gauge) branches off at Campbell station, 5 miles out of San Jose. The Almaden line of the coast division (broad gauge) branches off at Hillsdale, also 5 miles out of San Jose. From Hillsdale to Almaden station the distance is 8 miles, and from Campbell 10 miles. The public wagon road does not extend beyond the hacienda. From the hacienda to the mines on the hill leads a wagon road built with a grade of 9 feet to 100 for a distance of 2 miles to the hill office, and thence 0.5 mile more to Spanishtown. Branches from this road lead to all shafts, the planilla, and the ore bins. The whole length of main road and branches combined is 10.8 miles. Another wagon road leads to the company's woodlands, a distance of 5 miles.

### WATER SUPPLY.

The water supply on the hill is derived from 3 sources, springs which furnish between 30 and 55 gallons per minute, or from 40,000 to 80,000 gallons per 24 hours, according to season. The main supply comes from the so-called Black Hills, a part of the coast range of mountains, south of the mines, about 2.5 miles distant. The water is carried in pipes and distributed in water tanks, from which the branch pipes lead to the shaft houses and dwellings. The amount of water stored in the tanks on the hill is 157,400 gallons. There are 8 tanks of 15,000 gallons capacity each, 2 of 10,500 gallons, 2 of 2,700 gallons, and 5 of 2,200 gallons. The main Black Hills pipe and branch pipe lines are composed of 2.5-inch pipe, 4,750 feet; 2-inch pipe, 4,500 feet; 1.5-inch pipe, 4,050 feet, or a total of 13,300 feet, and branches of 2, 1.5, 1, and 0.5 inch pipe, together, 14,800 feet. The total length of pipes is 28,100 feet, or 5.32 miles.

As protection against fire there are 12 hydrants, each provided with 50 feet of hose, distributed at the different shaft houses and in front of the office and store.

The water supply to the hacienda and furnace yard comes from 3 springs and from Alamitos creek. A dam across Alamitos creek diverts the water into a wooden flume 14 inches wide and 12 inches high and is carried through the flume a distance of 2,500 feet to a pressure box at the south end of the furnace yard. From this pressure box a sheet-iron pipe, 14 inches in diameter and 845 feet long, brings the water to the penstock of the overshot water wheel, which drives the machinery of the machine shop, the blower for the blacksmith shop, a 28-inch circular saw for sawing wood, a lathe, and a 16-inch circular saw in the carpenter shop. When not used for this purpose it provides power for a pressure pump, which delivers water by a 4-inch and 6-inch pipe, 650 feet long, into the large water tank as supply for the balance hoists. The water wheel has a diameter of 20 feet, is 6 feet wide, and gives, according to the amount of water available, from 3 to 5 horse power. Surplus water from the penstock of the water wheel passes through 300 feet of 6-inch pipe into a 6 by 12 inch wooden flume 2,813 feet long, that runs along the foot of the hill on the west side of the hacienda village and distributes water for domestic purposes. The water escaping from the wheel runs into a ditch, which carries it along the road through the village and is used for irrigating purposes. The total length of pipe lines is over 8,000 feet, consisting of 6, 4, 3, 2, 1.5, 1.25, and 1 inch pipe.

There are 5 large storage tanks; 2 of these, with an aggregate capacity of 6,900 cubic feet, are located 300 feet above the floor of the furnace yard. These tanks are supplied with water by a spring in Deep gulch, carried by a V flume 1,400 feet in length. The water is used for fire plugs, of which there are 11 2-inch hydrants and 10 1.5-inch hydrants distributed throughout the furnace yard. A tank of 4,530 cubic feet capacity is located on the hill slope west of the furnaces, 80 feet above the furnace floor of Nos. 7 and 9, supplied from the overflow of the higher tanks just mentioned.

### SURVEYING.

It is estimated that up to the present time the total distance driven in the New Almaden quicksilver mines, in the form of tunnels, drifts, shafts, crosscuts, inclines, and winzes, is over 46 miles. From ore stopes over 1,500,000 tons of material have been extracted. The bulk of this network of excavations is included in an area 6,000 feet square, and has a vertical extent from the summit of Mine Hill to the lowest level of nearly 2,300 feet.

### MINING.

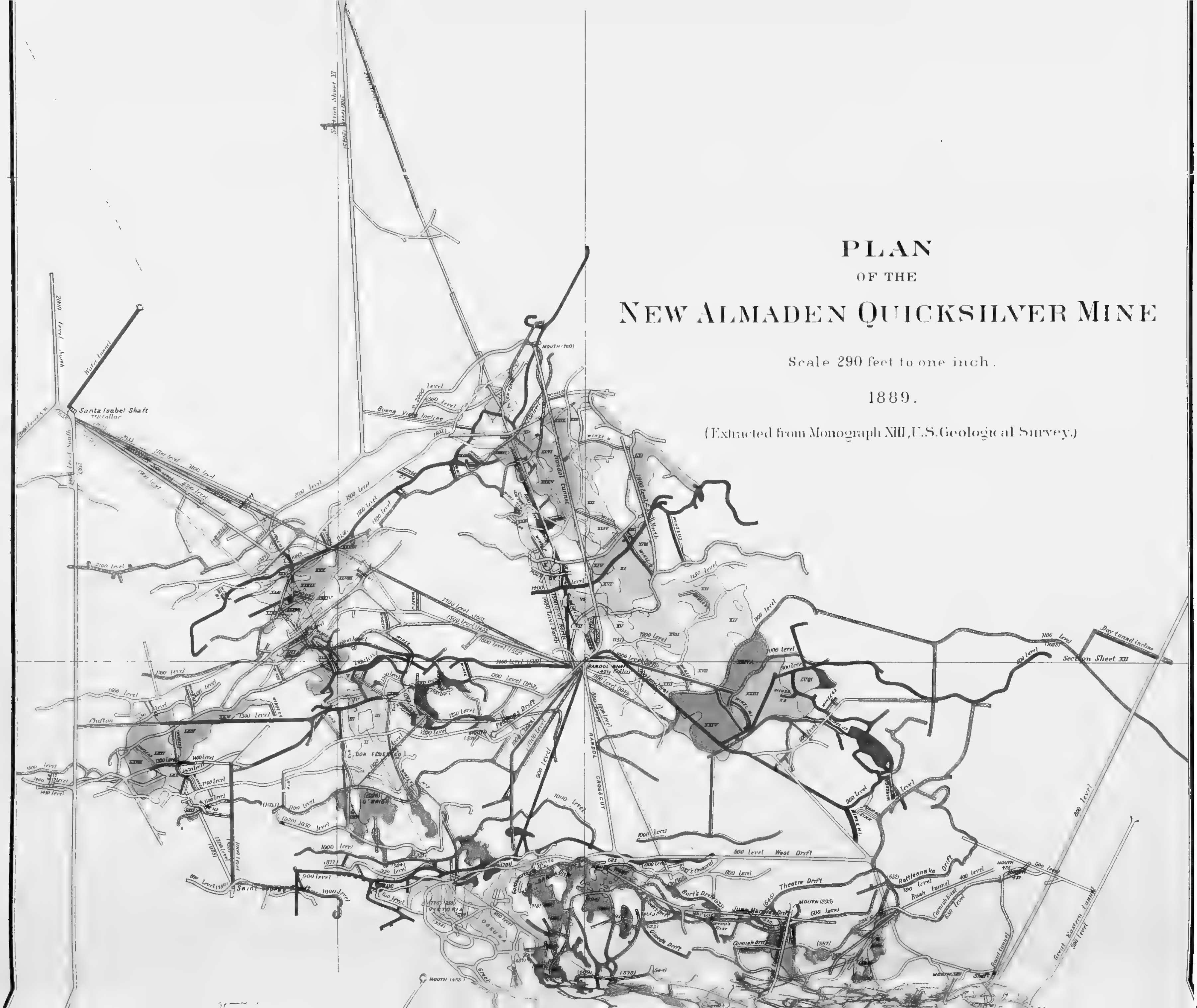
The place of the first prospect work was on the southeast slope and 160 feet below the top of Mine Hill, which is the highest summit of the ridge on which the mines are located. The work of exploration consisted of a tunnel driven into the hill that intersected some of the small veins of cinnabar. The work progressed slowly under the supervision of Castillero and Padre Real, one of his partners in the property, with a few Indians to do the work. In December, 1846, the property was transferred under certain conditions to the firm of Barron, Forbes & Co., of

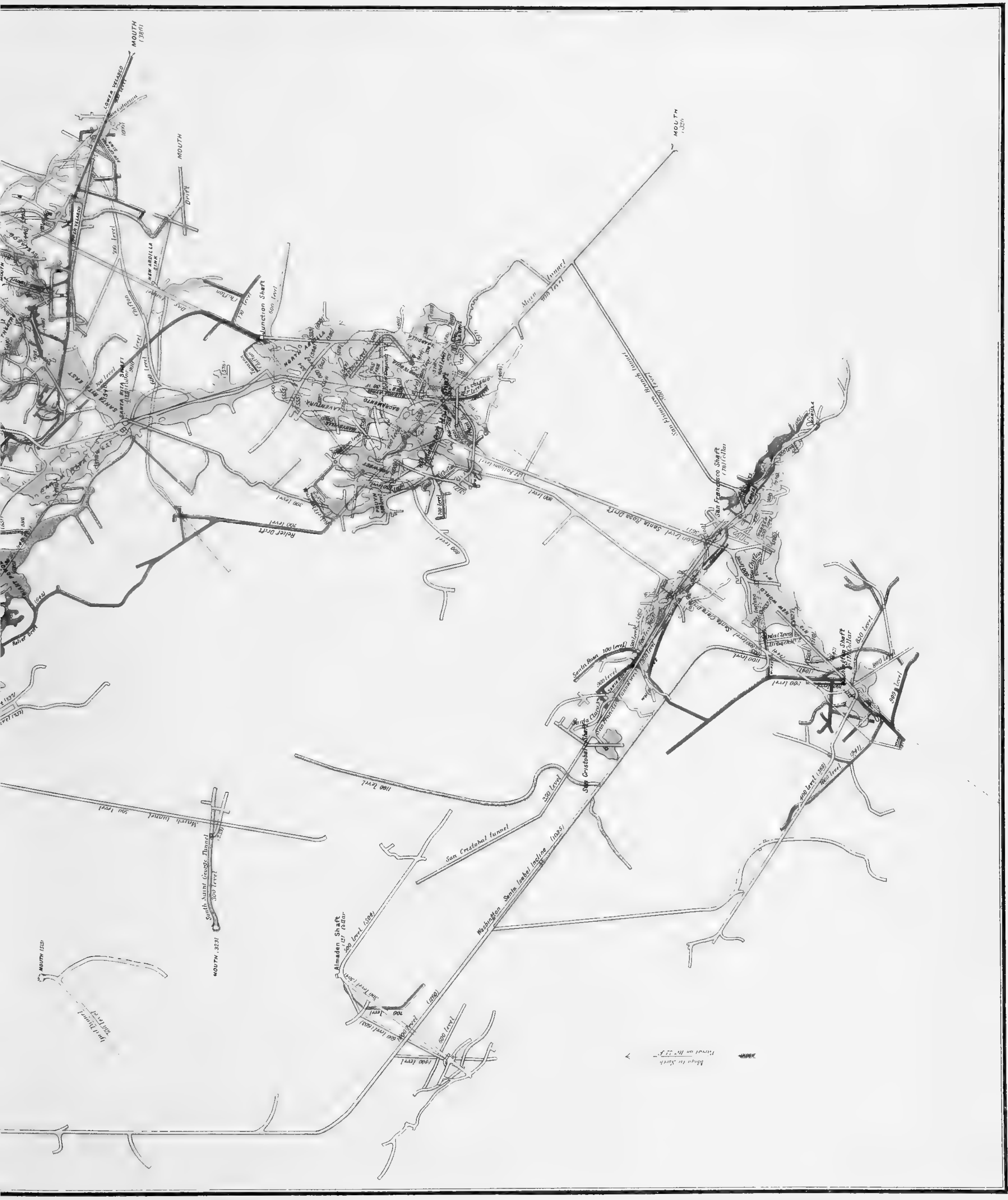
# PLAN
OF THE
# NEW ALMADEN QUICKSILVER MINE

Scale 290 feet to one inch.

1889.

(Extracted from Monograph XIII, U.S. Geological Survey.)




MOUTH (386)
LOWER VELASCO
MOUTH
Drift
NEW ARDILLA SINK
Junction Shaft
500 level
700 level
SANTA RITA SHAFT
SANTA RITA EAST
NORTH ARDILLA
SACRAMENTO
Main tunnel
MOUTH (321)
San Francisco Shaft
Santa Rosa Drift
Relief Drift
700 level
600 level
Santa Rosa 100 level
San Cristobal Shaft
250 level
San Cristobal tunnel
1100 level
800 level
900 level
400 level
Washington Santa Isabel Incline
Almaden Shaft
300 level
South Saint George Tunnel
300 level
MOUTH (323)
MOUTH (533)
500 level

the following mines or prospects: (1) the Senador, (2) the Purissima, (3) the San Antonio, (4) the Enriquita, (5) the Providencia, (6) the America, (7) the San Pedro and Santa Mariana, (8) the San Francisco, this last one being on the south slope of Mine Hill, but disconnected from the workings of the main tunnel. There were also a great number of tunnels and prospect shafts scattered wherever indications of ore had been found.

The general outlook was not very encouraging. The total length of all the drifts, tunnels, shafts, and winzes opened in the outside mines amounted to 29,919 feet, not including any of the workings in the Almaden mine proper, opened from the main tunnel and Day tunnel. The great ore bodies had already been systematically worked during 14 years. The great Ardilla labor, one of the largest and richest ore deposits, had been worked out to the northwest, and the mine, having produced so largely for many years, was now confined to a small extent of ground. Other ore bodies were still unknown, and the prospects for the future were doubtful.

All excavations in the mine worked as mineral ground, including ground strictly productive of cinnabar, but not including all the mouths of tunnels and adits, were contained in a parallelogram of 450 by 600 feet.

THE DAY TUNNEL had intersected a large area of barren ground, and was connected with the upper workings in 1871, when it gave facilities for ventilation, transportation, and drainage that were much needed. The principal vein that had been followed northward dipped northward, and it was expected that the continuity of the ore would be found in that direction. A small branch of ore observed in the beginning of 1865 extended northward from the Great Ardilla labor, and widened out and improved gradually until 20 men were here employed in breaking ore. When this ore body finally gave out, in August of the same year, another ore deposit was discovered on the 600-foot level. This ore deposit, called Santa Rita labor, opened out into one of the most valuable deposits ever known in the mines. The ore was of the richest quality, and up to the end of 1867 yielded alone 5,149 tons of ore. The labor extended from the north Ardilla, on the 600-foot level, in a northerly direction and almost horizontally, a distance of 375 feet. Here it divided into 2 branches, one called the Santa Rita East the other the Santa Rita West. The Santa Rita East extended a further distance of about 200 feet, the Santa Rita West more than 300 feet. The width of this large ore deposit varied between 30 and 100 feet, with a height or thickness of ore ground from 20 to 40 feet. The Santa Rita proper, discovered in 1865, became exhausted in 1871, having yielded a total of 11,616 tons of rich ore. The Santa Rita West was discovered in 1868 and exhausted in 1870. It yielded a total of 5,937 tons of ore. Altogether the labores named Santa Rita produced a total of 25,294 tons of ore, that averaged not less than 10 per cent quicksilver.

While these discoveries took place in the Santa Rita ground the other parts of the mine were still worked and produced some ore, and the more prominent labores were some above the 300 level, and below this level the Pruyn, La Cruz, Dios te Guia, 10-fathom and 27-fathom levels, the Collegio, Buenos Ayres, Sacramento, Far West, Santa Rosa, the Velasco workings, and some of the outside mines, all adding their quota to the general ore production. As the works progressed still farther north and extended east and west, the ore bodies grew smaller and more scattering, spread out and dipped more steeply north and west. A notable exception in this general downward dip was the connection with the ore body known as the Velasco group that rose upward and was opened by the Velasco tunnel in 1864 (400 level), and another tunnel called Road tunnel. Both tunnels furnished small deposits of high-grade ores, which reached to the 500 level, and descended from what was known as the Theater labor, worked in 1872, steeply to the 600 level. Here the ore disappeared and only barren vein matter remained.

The northwestern explorations opened up the labores known as the Giant Powder (620 feet), the Ponce (624 feet), the New Santa Rita West (640 to 700 feet), discovered in 1871, the Santa Ana, Ossuna and Victoria (637 to 776 feet). These ore bodies apparently formed the northern boundary of the pay chute. The vein, here smaller in size, took a sudden steep plunge down to the 900-foot level with only small detached ore deposits, and in 1873 the mine gave little promise of continuance.

As the bodies of ore discovered during the past years had continued in their northward course with a dip north and west, the only remedy remained to search for the new ore bodies in that direction and at a greater depth, the Day tunnel being too high for these explorations.

On June 10, 1871, ground was broken for a new working shaft. This shaft, called the Randol shaft, named after the manager of the property, was located on a spur of Mine Hill at an elevation of 426 feet below datum point, 359.5 feet above the mouth of Day tunnel, and about 440 feet north of the rich workings in the New Santa Rita West. The Randol shaft reached the vein 1,151 feet below datum, on the twelfth level. The explorations from this shaft were of the greatest importance for the future of the mine, as they disclosed two prominent ore chimneys, one lying east, the other west, of the shaft. In the western ground they continued almost without interruption from the Great Santa Rita labor (700 level) down to the 2,200-foot level of the mine, while in the eastern ground the ore deposits began at the 900 level and extended to the 1,900 level.

These ore bodies have had a width of 100 to 300 feet, and a thickness from 12 to 20 feet and more, and have up to the present time yielded the regular supply of ore. With this same object in view, other shafts were sunk from time to time and connected by underground workings with the general system from the Randol shaft, viz: the Santa Isabel shaft, started in 1877, reaching down to the 2,300-foot level; the Buena Vista shaft, started in 1882, also reaching to the 2,300-foot level, and the Saint George shaft, in 1887, reaching to the 1,200-foot level. South of Mine

Hill the Washington shaft, begun in 1881, reached down to the 1,100-foot level. The Santa Rita shaft was opened in 1884 as a prospect shaft from the ground above the Santa Rita labor, and sunk to the 900-foot level, piercing through the old Santa Rita labor.

HACIENDA TUNNEL.—The mouth of this tunnel is 1,800 feet south 15° west (magnetic) from the hacienda office in the ravine of Alamitos creek, which flows through the furnace yard of the hacienda. Its mouth is 1,202 feet below the summit of Mine Hill. The course is north 70° 25′ west from its mouth for a distance of 1,848 feet, when it takes a more northerly deviation for 492 feet, then returning again to an almost westerly course for 496 feet; total length, 2,836 feet. The tunnel was started in January, 1867. Its object was to serve as a drain tunnel for the mine and for transportation. After having advanced a distance of 486 feet work was stopped. The developments in the Cora Blanca mine, made in 1874, with a rich ore body in sight, and apparently crossing the hacienda tunnel line, have new encouragement, and the tunnel was continued again in December, 1874, this time with machine drills, to insure its speedy completion into the ore ground of the Cora Blanca mine. In October, 1876, it had reached a distance of 2,135 feet without intersecting any vein. Work was then temporarily stopped, while the Gray shaft was sunk to the 1,000-foot level. The tunnel work was again taken up in January, 1878, and, having reached a total distance of 2,340 feet from the mouth, the direction of the tunnel line was changed to a course of almost due west (magnetic) to intercept the productive vein of the Cora Blanca mine, which indicated a pitch in that direction, and a large vein, 30 feet wide, was intersected, on which branch drifts were run north and south for 130 feet. The indications, however, were so unfavorable that all further progress was stopped in August, 1879.

THE CORA BLANCA MINE.—This mine is situated on the east slope of Mine Hill in a direction a little south of east of its summit and from it about 1,300 feet distant. Its vein is entirely disconnected from the vein system of the main mine, running on a true north and south course and dipping east. The ore deposits were discovered in 1864, and produced 1,800 cargas (*a*) of high-grade ore during the first 3 months. The openings then consisted simply of surface works, opened by tunnels. The ore was found in bunches in a vein close to the surface. These upper works were soon exhausted. In 1873 a shaft was sunk, called the Cora Blanca shaft, collar 574 feet below datum, which struck ore at a depth of 53 feet. Steam hoisting works and a pump were erected. A tunnel that had been started in the ravine, 1,000 feet east from the shaft, called the Deep Gulch tunnel, connected with the Cora Blanca shaft in 1874, its elevation being 770 feet below datum (summit of Mine Hill). In 1875 the Cora Blanca mine produced 6,262 cargas of rich ore. The yield lessened in 1876, the vein becoming much harder below the level of the Deep Gulch tunnel (800 level). Another shaft, called Gray shaft, was sunk in 1876, about 660 feet east of the Cora Blanca shaft, and alongside of the Deep Gulch tunnel, 350 feet from its mouth, to prospect the vein at greater depth. The steam hoist and pump were transferred from the Cora Blanca shaft, and the shaft was continued down to the 1,100-foot level. As all efforts to find ore below the 800 level proved futile, the mine was abandoned in 1879. The Cora Blanca shaft has connection with the 600, 700, 800, and 900 levels; the Gray shaft has stations at the Deep Gulch tunnel level (764 feet), the 900, 1,000, and 1,100 levels (846, 944, and 1,045 feet below datum).

THE SAN FRANCISCO MINE was opened in 1864. It is situated on the south slope of Mine Hill, about 650 feet southwest from main shaft. The vein has a northwest and southeast course, and had originally been opened by 2 adits, the upper San Francisco and the lower San Francisco tunnels. As the work progressed downward the vein improved in character, but the yield was irregular. The workings were connected with the main tunnel by the San Francisco branch tunnel in 1869. The ore production of the San Francisco mine in 1866 amounted to 7,238 cargas, reached 13,686 cargas in 1867, and diminished to 8,661 cargas in 1868. In 1868 a shaft, called the San Francisco shaft, was sunk from the 300 level, and in 1869 connected with the Santa Rosa or 600 level. (*b*) It was provided with a steam hoisting engine, set up at the shaft on the 300 level. The labores on the 300 level and above the Manilla and Arcial on the 400 level and the Warren on the 500 level were the most prominent, the last producing nearly 4,000 cargas in 1871. In June, 1874, the New World labor was discovered from the 600 level. This labor extended 220 feet in length, more than 80 feet in width, with a height from 10 to 20 feet, and produced high-grade ore. From the surface down to the 500 level the vein maintained an almost perpendicular position. The vein of the San Francisco mine has an average width of from 50 to 60 feet. It has been prospected over a length of 900 feet, and was found productive over a length of 500 feet. In the New World labor the vein took a pitch of about 45° southwesterly and finally connected with the 800 level, the Santa Clara, which is a continuation of the Day tunnel. This continuance of the ore body led to the establishment of Washington shaft, first called Garfield shaft, which was begun in November, 1881, at a point 470 feet southwesterly from the San Francisco shaft. The Washington shaft starts from the surface, its collar being 176 feet below the summit of Mine Hill. In June, 1882, 416.5 feet of the 3-compartment shaft had been sunk and met with the upraise, 142.5 feet high, from the Santa Clara drift, a total of 559 feet, then continued down to the 1,100 level, which it reached in January, 1885. The 800, 900, 1,000, and 1,100 stations completed, vigorous prospecting was carried on. However, the ore bodies found were limited in extent and reached only to the 850 level. Below this the vein became flatter and spread out in every

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*a* A carga is a Mexican load of 300 pounds.

*b* The San Francisco shaft has stations at the 300, 400, 500, and 600 levels, at 320, 370, 465, and 560 feet, respectively, below datum.

direction, while the ore showed only in small branches. The regular prospect work from the shaft was discontinued in the winter of 1887.

**The San Pedro and Santa Mariana mines** have been only superficially developed. Shallow shafts or inclines and prospect drifts of short distances were driven in a very irregular way by prospectors in following the ore indications, and as they were not very encouraging little attention was paid to systematic development. The 2 prospects formed simply an adjunct to the larger mines. In November, 1864, altogether 1,608 feet of tunnels and shafts had been drifted in the San Pedro and 1,547 feet in the Santa Mariana ground. The vein has apparently a connection with the San Francisco vein. The ore production in San Pedro and Santa Mariana virtually stopped in 1868, although small amounts of ore were broken by tributers from time to time in later years.

**The America mine**, previous to 1864 called "Bull Run", was opened in September, 1863. The mine is situated 1,500 feet northwesterly from the San Pedro workings. The surface of the ground shows much broken vein matter. A tunnel called Upper America, driven 175 feet in length to drain the upper workings, which had started with a small shaft, was completed in July, 1865. Its mouth is on the south slope of the hill, about 100 feet perpendicular below the shaft before mentioned. The ore veins in descending become narrow and almost perpendicular. Another tunnel was started 120 feet lower, called the Lower America tunnel, and driven a distance of 750 feet, as the ore bodies pitched a little to the north. A shaft 216 feet deep was then sunk from the surface. Considerable water was found, and gave much trouble. As the expense of erecting pumping works was not likely to be compensated by the ore in sight, further work was stopped, the engine was removed, and a long tunnel, known as the Great Western, was projected and driven some distance. The ground became very hard, the distance to be driven (1,170 feet) was considerable, and as only 150 feet in depth were gained by it, the work was stopped in 1867. Some metal was broken from the old workings in 1868, 1869, 1873, and 1874 by tributers.

In October, 1885, a new 2-compartment shaft was sunk, with steam hoisting works and pump, about 200 feet southwest from the old shaft. The mouth of this shaft is 147 feet below datum point. It reached the 700 level in March, 1887.

Stations were established at the 500, 600, and 700 levels, at 411, 506, and 601 feet below datum, the 500 level connecting with the lower America tunnel. The developments from these upper levels were unsatisfactory, and the 700 level was very wet. The shaft was sunk 200 feet deeper in the year 1888, with the intention of connecting it with a crosscut from the 1,400 level, Santa Isabel shaft. A large outburst of water injured the shaft in July, 1888, and the unstable character of the ground, combined with the great cost of sinking 400 feet deeper, also the little encouragement which the lower developments had given, resulted in the temporary abandonment of this mine.

**The Providencia mine** is about 4,800 feet southwesterly from the new America shaft. It consists mainly of surface works that were opened before 1864. Several small drifts were run into the south slope of the main ridge, which is all vein rock. One, called the Providencia tunnel, 711 feet below datum, reached ore at the distance of 120 feet. Another, the Ravine tunnel, 866 feet below datum, was started in 1864, 155 feet below the Providencia tunnel. Its whole length, straight, is 470 feet, with a branch 142 feet. Some prospecting was done in 1867 and 1871, with poor results. This mine has remained idle ever since. It is stated that it produced several thousand cargas of superior ore.

**The Enriquita mine** is situated 2,000 feet northwest from the Providencia tunnel, on the south slope of the main ridge. The ore body had the shape of a flat arch, its western end with the course north 33° west, the east end south 68° east (magnetic), and a total length of 550 feet, not continuous, but with interruptions in length as well as in depth. This mine was opened in 1859. 3 principal tunnels had been driven—the main tunnel, the Federico tunnel (870 feet below datum), and the Esperanza tunnel, the first one being the lowest. From these tunnels the ore bodies were developed by shafts, winzes, and branch drifts. The upper works being nearly exhausted, the Eldredge tunnel was started in 1863, at the lowest point obtainable in the ravine of Capitancillos creek (1,180 feet below datum), for the purpose of gaining greater depth in the mine and to ventilate and drain the upper works, which had been troubled by foul air and water. In 1865 the Eldredge tunnel had reached a distance of 619 feet; 60 feet were added in 1867. The work was continued in later years from time to time until, in 1874, the tunnel had reached a total length of 875 feet. In 1874 work was again resumed in the upper mine, and prospecting was done in the San Andreas ground, where 282 feet were drifted. Very little ore, however, was found. At the end of March, 1875, all work was discontinued at the Enriquita mine, as the low prices of quicksilver did not encourage prospecting at a point so remote from the general works.

**The Purissima mine** was worked to a small extent in 1860, and it is said that rich ore was found. In 1864 the whole prospect work aggregated 194 feet of drifting and sinking.

The San Mateo shaft of this mine, which lies about three-quarters of a mile northwesterly from the Enriquita mine, was sunk in 1874 through ore ground a distance of 87.5 feet. The ore, however, appeared only in small branches. Further explorations were stopped for the same reasons which led to the suspension of work at the Enriquita.

**The San Antonio** adjoins the Purissima ground on the east; development, 588 feet of drifting and sinking.

**The Senador mine** is nearly 1 mile northwest from the San Mateo shaft on the north slope of the ridge, and within one-quarter of a mile from the western boundary of the company's lands, adjoining here the lands of the Guadalupe Mining Company. A small shaft and tunnel were driven and sunk, and some 400 cargas of good ore were taken out. A tunnel 40 yards lower in elevation was driven in 1873. No work has been done at this mine since then, when the total length of drifts and shafts amounted to 480 feet.

The illustration of the underground workings shows the present condition of the New Almaden mine. The table following gives the co-ordinates and elevations of the different shafts and tunnels, the datum point for co-ordinates being a point 30 feet distant on the line and outside of the Hacienda tunnel, marked by a monument post. The datum point for the elevations is a monument on the summit of Mine Hill, from which all levels on the surface as well as underground have been determined. This point is 1,755 feet above sea level.

CO-ORDINATES, ELEVATIONS, ETC., OF PRINCIPAL SHAFTS AND TUNNELS.

[Feet.]

| No. | SHAFTS AND TUNNELS. | CO-ORDINATES FROM MONUMENT H. | | Elevation of collar of shaft below datum point. | Lowest level opened. | Absolute depth from surface. |
|---|---|---|---|---|---|---|
| | | North. | West. | | | |
| 1 | Main shaft (*a*) | 1, 760 | 4, 945 | 317 | 700 | 345. 0 |
| 2 | Randol shaft (*b*) | 3, 535 | 5, 445 | 426 | 1, 800 | 1, 340. 0 |
| 3 | Santa Isabel shaft (*b*) | 4, 105 | 6, 595 | 728 | 2, 300 | 1, 526. 0 |
| 4 | Buena Vista shaft (*b*) | 5, 060 | 5, 990 | 885 | 2, 300 | 1, 375. 0 |
| 5 | Saint George shaft (*a*) | 3, 020 | 6, 240 | 570 | 1, 200 | 548. 5 |
| 6 | Almaden shaft (*b*) | 1, 990 | 6, 245 | 275 | 700 | 484. 5 |
| 7 | Santa Rita shaft (*a*) | 2, 480 | 5, 015 | 125 | 900 | 761. 5 |
| 8 | Washington shaft (*b*) | 830 | 5, 605 | 176 | 1, 100 | 880. 0 |
| 9 | San Francisco shaft (*b*) | 1, 130 | 5, 245 | 78 | 600 | 485. 0 |
| 10 | Cora Blanca shaft (*a*) | 1, 575 | 3, 565 | 574 | 900 | 275. 0 |
| 11 | Grey shaft (*a*) | 1, 390 | 2, 925 | 618 | 1, 100 | 457. 5 |
| 12 | America shaft (*a*) | 2, 240 | 8, 195 | 147 | 700 | 809. 5 |
| A | Main tunnel | 1, 245 | 4, 380 | 326 | (*c*) | ............ |
| B | Day tunnel | 3, 880 | 4, 000 | 785 | (*c*) | ............ |
| C | Hacienda tunnel | 25 | 70 | 1, 202 | (*c*) | ............ |
| D | Deep Gulch tunnel | 1, 305 | 2, 575 | 770 | (*c*) | ............ |
| E | Randol crosscut | 4, 245 | 5, 555 | 760 | (*c*) | ............ |
| F | Great Eastern tunnel | 3, 240 | 4, 190 | 528 | (*c*) | ............ |

*a* Closed. *b* Open. *c* At mouth.

The Junction shaft goes from the 600 level (Santa Rosa) to Day tunnel, or 800 level; co-ordinates, 2,170 north and 4,810 west.

The shafts of the outside mines are not comprised in this list; neither are the tunnels, as they are of little importance now. The above shafts are those that are or have been provided with steam hoisting works. Those mentioned as opened are in first-class working condition at present date. The tunnels or adits are all open, with the exception of the Hacienda tunnel.

The main horizons or levels are opened from these shafts at distances of 100 feet, more or less, perpendicularly, the absolute elevation being determined by local necessities, as connection with levels from other shafts already opened, or with adit tunnels, etc.

The aggregate length of all shafts, winzes, drifts, tunnels, and crosscuts was 46.35 miles at the end of December, 1889, not including many prospect drifts that were run during the first few years of mining at Almaden and Enriquita, as no record has been kept of these places.

The usual method of prospecting for ore during the first period of mining at Almaden, that is, from 1845 to 1870, nearly, consisted in crosscutting the vein and then following the indications of the small cinnabar veins, called by the Mexican miner "hilos", that usually led to larger deposits. This method was followed in the upper portions of the vein, where the ore bodies occupied all possible positions, sometimes near the middle of the body of vein, sometimes near the hanging wall. Later explorations in depth demonstrated, however, that ore bodies almost persistently followed only the contact of the hanging wall (called "alta" by the Mexican miners) with the vein. The explorations, therefore, were always along the alta wall of vein, no matter how tortuous the direction might be. The ore ground above the 800 level was much more irregular and scattered than that below this depth, where 2 prominent ore chutes were developed, which could be relied on with almost positive assurance within certain limits. One of these chimneys, or ore chutes, is situated on the northeast side of the Randol shaft, the other on the southwest side, and they have been commonly called the north and south veins. The north vein has continued without interruption from the 900 level to the 1,900 level as ore bearing, but has been opened as far as the 2,300 level, the latter distance being barren. The south vein has continued, without any interruption whatever, as an ore-bearing vein from the top of Mine Hill down to the 2,200 level, a total distance, measured on its dip or slope, of nearly 3,800 feet. Below the 2,200 level this vein has proved barren. Branch veins were found in the hanging ground of these main veins, on the north vein as well as on the south vein. Their extension upward or downward, however, is not continuous, and the ore bodies were developed by crosscutting from the main levels. This second vein system is so irregular and uncertain that no reliance can be placed on its being met with by crosscuts. It is only by a very broad and general comprehension of the vagaries of the cinnabar ore bodies that anything like a favorable result might be anticipated. This must explain the enormous amount of underground work done in these mines. The ground explored by the different shafts, including the Washington and Cora Blanca, occupies an area of over 1 square mile.

The early developments of the New Almaden mines were by adits and small shafts, as they are commonly used by the Mexican miners, who were the first laborers employed. The unknown structure of the vein and its apparent irregularity made it difficult during the first period of mining to decide upon a system to be followed throughout. The introduction of English miners (Cornishmen) brought about a decided change in the methods of working, and the use of steam hoisting works and pumping engines obliterated all differences that might have existed in the deep mining employed at New Almaden and elsewhere. Some local customs and arrangements exist, however, and to explain all these a full description of the methods of mining as pursued at New Almaden will be given in the following pages.

At the present day ore is brought to the surface from great depths, and the underground work is entirely done through shafts. From these shafts levels are excavated at regular intervals of about 100 feet. From these levels the prospecting work is prosecuted by drifting, sinking, or upraising, as circumstances may require, along the vein, or crosscutting the hanging wall or foot wall in search of other veins or ore bodies. These explorations are not confined to one level at a time, but include several. The ore bodies when found are usually extracted by stoping out overhead, although underhand stoping is often resorted to.

SHAFTS.—The shafts resemble each other in general features. They are vertical and timbered throughout. The size of their timbers and the distance between sets of timber vary according to the size of the shaft and the nature of the ground through which they have been sunk.

The Randol is the principal working shaft, and has held this place during the past 16 years. It has only 2 compartments, one for hoisting, the other originally for pump work, but at present only used for ladder way. Its size is 4 by 9 feet in the clear, the hoisting compartment being 4 by 4 feet, the pumping compartment 4.5 by 4 feet, and a 6-inch partition between the 2 compartments. It is closely cribbed with 8-inch timbers from top to bottom. The collar of the shaft is 426 feet below datum point. Its actual depth to the bottom of the sump is 1,340 feet. Beginning at the 800-foot station (758 feet below datum), connected with the surface by an adit level, the Randol crosscut, the shaft is provided with stations at every 100 feet of depth, the lowest being the 1,800-foot station, and level, at 1,751 feet below datum.

The Santa Isabel shaft has 3 compartments, 2 for hoisting and 1 for pumping. The shaft is 13 feet 8 inches long by 4 feet 6 inches wide in the clear, each hoisting compartment being 3 feet 8 inches by 4 feet 6 inches; the pump compartment 5 feet by 4 feet 6 inches. The partitions between the compartments are 8 inches thick. The timbering consists of open sets of 10-inch timber with lagging from the collar down for a distance of 60 feet, followed by close cribbing with 8-inch timbers for 240 feet; then again open sets of 10 by 10 inch timbers, and farther down of 10 by 12 inch timbers. The open sets of 10-inch timber are 3 feet between centers; the 10 by 12 inch sets are placed at 3 feet 6 inches between centers. The pump compartment also contains the ladder way. The collar of the shaft is 728 feet below datum; the actual depth to bottom of sump is 1,526 feet. From this shaft stations are established at the 1,400, 1,700, 1,900, 2,000, 2,100, 2,200, and 2,300 levels, represented, respectively, by 1,303, 1,653, 1,856, 1,957, 2,035, 2,134, and 2,234 feet below datum point.

The Buena Vista shaft is 5 by 15 feet clear inside of timbers, and has 2 hoisting and 1 pumping compartments. Each hoisting compartment is 3 feet 8 inches wide. The pump compartment is 6 by 5 feet, and is provided with ladder way. The shaft is closely cribbed from the collar down for 50 feet with 12-inch timbers. Then follow open sets of 12 by 12 inch timbers, 3 feet between centers. The partitions are 10 inches thick. The collar of the shaft is 885 feet below datum point, the bottom 2,260 feet below datum, or 509 feet below sea level, making a clear depth of shaft of 1,375 feet. An adit level connects with the shaft 306 feet below the collar, used as drain level for the water raised by the pumps. Only 2 stations are established in this shaft, 1 at the 2,100-foot level (2,046 feet below datum), and 1 at the 2,300-foot level (2,246 feet below datum). Explorations below the 2,100-foot level having been suspended, the shaft has filled with water to that level.

The Saint George shaft is 4 by 8 feet in the clear, with 1 hoisting and 1 ladder-way compartment. Its total depth is 548.5 feet, including the sump. The collar of the shaft is 570 feet below datum point. The timbering consists of open sets of 10 by 10 inch timber, 3 feet between centers. Stations have been established at the 800 level (750 feet below datum), the 1,000-foot level (930 feet below datum), and the 1,200-foot level (1,105 feet below datum).

The Almaden shaft is 4 by 9.5 feet in the clear, with 1 hoisting and 1 pumping compartment, the latter containing at present only a ladder way. The shaft is timbered with open sets of 10-inch timber, 3 feet 3 inches between centers. The collar is 275 feet below datum point, the bottom at 759 feet; total depth, 484.5 feet. Stations have been established at the 500, 600, and 700 levels. This shaft is not connected with the other parts of the mine.

The Washington shaft, 4 by 14 feet in the clear, has 3 compartments, 2 for hoisting and 1, originally used for pumping, containing now only the ladder way. Its collar is 176 feet below datum point. The levels established are the 400 at 368 feet, the 800 at 741 feet, the 900 at 841 feet, the 1,000 at 941 feet, and the 1,100 at 1,041 feet below datum. There is also the 850-foot level at 795 feet, but without station at the shaft and connected by a short crosscut only. The total depth of the shaft from collar to bottom of sump is 880 feet.

The Santa Rita, America, Cora Blanca, Gray, and Main shafts are 2-compartment shafts.

The San Francisco was originally an underground shaft, and has only lately been driven to the surface, its collar being now at 78 feet below datum point, while originally it only started from the 300-foot level (320 feet).

The Santa Rita shaft was begun in December, 1884, for the purpose of prospecting the ground above and below the old Santa Rita labores. It reached its total depth of 761.5 feet in March, 1886. The greatest depth sunk in 1 month in serpentine was 150.5 feet. Its collar is at 125 feet below datum. The shaft is connected with the Juan Vega tunnel (300 level), the 800 level, 780 feet below datum, and has a station and level at the 900 (880 feet below datum).

The Main shaft starts from the 300 level (main tunnel) and has stations and levels as follows: 10, 20, and 27 fathom levels (at 380, 445, and 482 feet below datum), Bestor's level (at 510 feet), the Santa Rosa or 600 level (at 571 feet), the Little Plat level (at 600 feet), and the Relief or 700 level (at 667 feet below datum).

The America, Cora Blanca, and Gray shafts are timbered with open sets of 10 by 10 inch timbers, 3 feet apart, the partition timbers being 6 by 8 inches in section.

SHAFT TIMBERING.—The timbering of the shafts is done from the surface downward as the sinking progresses. Sawed redwood timbers are used for the framework of the sets. These sets are secured horizontally, either close together in very heavy ground (cribbing), or at certain distances from each other (open sets). The open sets are kept apart vertically by posts or studdles at their corners. Between the sets the ground is covered by lagging 3 inches by 6 inches in section, placed upright, and secured tightly against the timbers by wedges driven between the ground and the lagging. Cross-timbers for the partitions form a part of every set.

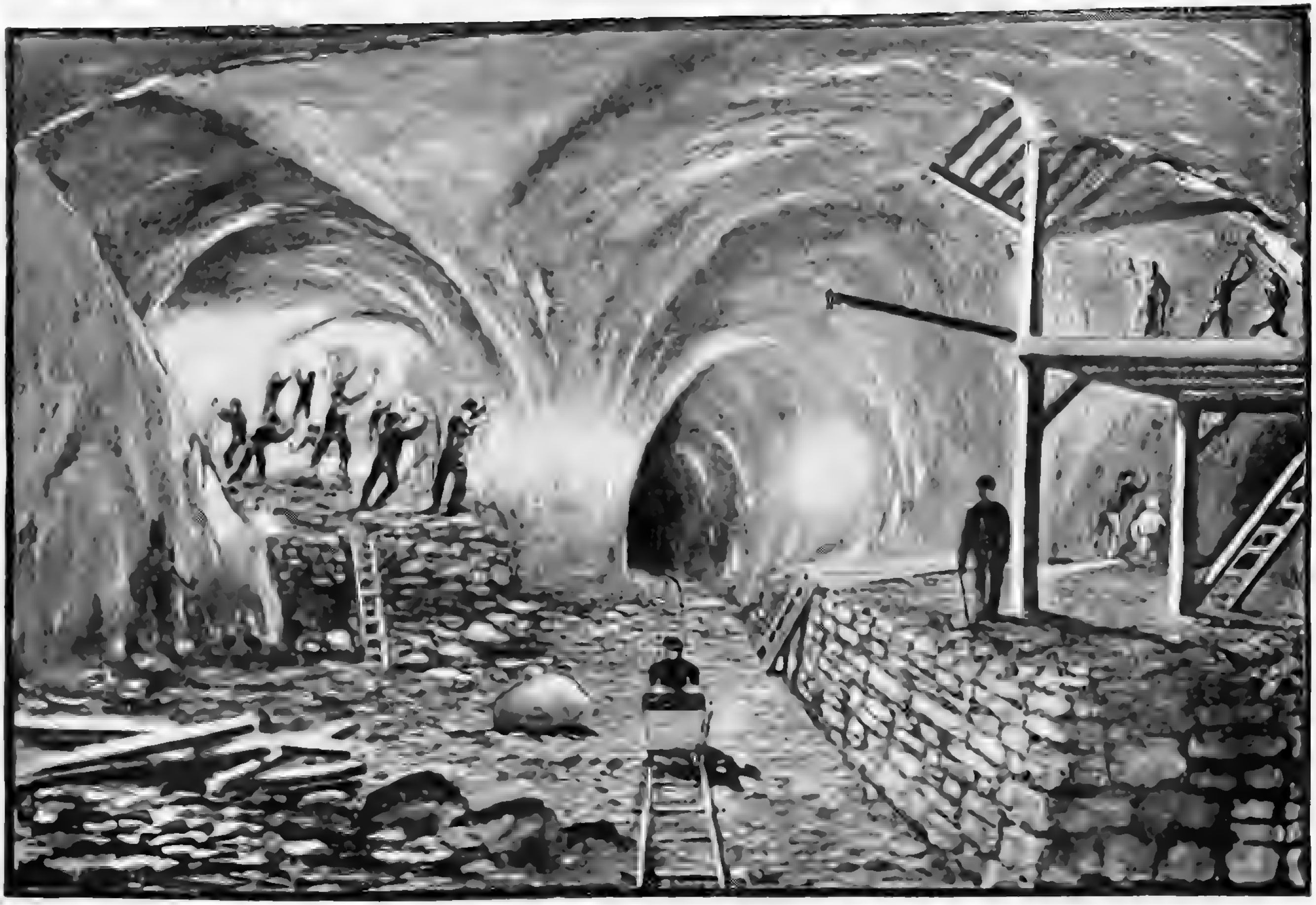
The sizes of the timbers forming the sets are selected according to the size of the shaft and the nature of the ground, which also control the distance between the sets. The posts, or "studdles", as they are called, have simply squared ends, and after being placed in proper position are secured with heavy nails.

In the solid cribbing the end timbers rest against a 1-inch shoulder of the long pieces only. The timber sets for winzes of ordinary size are similarly framed, with shoulder joints at the corners and studdles to keep them apart, and lagging where necessary. This style of framing is changed in winzes that have more than one compartment, and in heavy ground when the timbers are framed like shaft timbers and provided with partitions.

When sufficient ground has been excavated to place a new set, the end timbers are first lowered down and put approximately in place by hanging them from the last set above. Round iron rods, with nuts and washers at one end and a hook at the other end, are passed through holes and secured by nuts in the last set above. Similar rods are passed through the new end pieces and hooked to the rods from above. The long sides of the frame are then lowered in place and the studdles secured in the 4 corners. The iron rods are then screwed up tight, when the new set is firmly held by the one above. The lagging is then put in place and nailed to the timbers, wedges driven firmly between the rock walls and the lagging, and the partitions put in place. When so arranged the new set is held in place by the lateral pressure of the ground, and the iron rods connecting the sets can be withdrawn after a time, although it is usual to keep them in place for 3 or 4 sets above the last one. Every 30 or 40 feet or so the end pieces of the sets rest upon other timbers, called bearers, that are made longer and have their ends for a certain depth supported in holes excavated in the wall rock at the proper distances. This depth depends upon the nature of the ground, being only about 4 inches in hard rock, and sometimes as much as 2 feet in soft ground. When the ground is too soft, or liable to give way, the bearers are omitted until firm ground is reached. Timber sets so adjusted last for many years, and with proper attention require very little repair. Should a set become broken from any cause, pressure of the ground or otherwise, or be forced out of the general alignment, it can be taken out and readjusted without much difficulty. In very heavy ground this method of timbering is replaced by solid cribwork, in which one set rests upon the other. Here the iron rods are dispensed with, and the sets are built up from below, precaution being taken to have sufficient space for the sets between the one first secured in the bottom and the others that are to follow on top to inclose the sides, the last remaining space being filled in by a piece of board, wedge-shaped to the required size and driven firmly between the sets.

Small prospect shafts have their sides timbered with 2-inch planking, no other timbers being used, except a few open sets near the surface of the ground. In this case the planks are sawed to proper lengths and placed horizontally with their faces against the sides of the shafts, the end planks being secured by pieces of 1 by 6 inch boards, nailed against the long sides to prevent the ends from being forced in. Wedges hold these planks firmly in place. The partitions are also made of 2-inch plank secured by 1 by 6 inch pieces. The planking is done from time to time as the depth of the shaft increases, and then from the bottom upward, as in cribwork.

The stations in the shafts from which the different levels start are chambers excavated, and timbered if necessary, extending the whole length of the shaft, usually 16 feet deep, and consist of 2 floors, called the upper and lower plats. The upper plat has its floor on a level with the car track of the drift starting from the plat, while the



FRANCISCO VELASQUEZ CHAMBER; A RICH ORE BODY IN 1865, AT NEW ALMADEN.

From a drawing by J. Ross Browne.

lower plat furnishes dumping room for the material to be hoisted to the surface. The upper plat is 7 or 8 feet high in the clear between the timbers. The dump plat has a capacity for about 30 tons of rock, which is dumped by the cars through an opening between the rails over the whole length of the plat. The upper plat is used for landing timbers and supplies or tools sent into the mine.

In opening a station for a new level, one of the long sides of the shaft sets adjoining the station with its lagging is taken out for the entire height of the 2 plats, and heavy upright timbers are inserted at the 2 corners of the shaft timbers and one opposite each partition, to take up the pressure of the other side. These timbers are called "brow pieces". The roof of the stations is either left unsecured (when in solid rock) or is timbered with horizontal or arched timbers, as the case may require, and is covered by lagging. The upper and lower plats have floors of 3-inch fir planking, that of the upper plat resting on 12-inch timbers or joists.

All the shafts and winzes are provided with ladder ways. The ladders have 2 by 4 inch redwood scantlings for sides, each piece 15 feet 7 inches long. The distances between the sides is 10 inches in the clear. The rounds of the ladders are 11 inches apart, made of five-eighth-inch round bar iron. The third round from each end of the ladder is made of three-quarter-inch round bar iron, with shoulders or bosses that abut against the inner side of the spars, and nuts screwed on the ends of these bars to prevent the spreading of the sides. In putting ladder ways in perpendicular shafts or winzes, 2 ladders are joined together at the sides by a piece of scantling, and, having the upper end secured to the shaft timbers by iron clamps, stand with their lower end upon small platforms built across the shaft, which gives them sufficient slope for greater ease in climbing. The next pair of ladders starts either from the same side of the shaft or from the opposite side, the head of the second ladders projecting sufficiently above the platform to afford a hold while the next step is taken. Inclined winzes have platforms at every second ladder when the winze is not used for other purposes, or have a continuous line of ladders if space should be required for hoisting or lowering.

TUNNELS OR DRIFTS.—The usual size of all drifts or tunnels is 7 feet high by 5 feet wide in the clear. In hard rock, which requires no supports to hold it in place, this cross section is of course irregular, but whenever the nature of the ground makes timbering necessary the cross section is obtained by the clear length of the timbers. The top or cap piece which supports the roof is 4 feet long in the clear, and the posts or legs are each 7.5 feet long in the clear, spreading to a width of 6 feet at the bottom. 2 posts or legs and a cap form a set of timbers. These are set from 3 to 5 feet apart, according to the nature of the ground, and covered with lagging on the roof and sides when the ground requires this precaution. The lagging is 3 by 6 inches in cross section, and of suitable length to cover the space between the sets. In drifts where a good solid vein is followed it is usual to dispense with 1 leg of the set, as the vein is hard enough to stand without breaking, and only the hanging-wall side and the roof have to be supported. The timber used is redwood, hewed to different sizes. The dimensions are selected according to the nature of the ground. The largest size timbers are 16 by 16 inches square, the smallest 8 by 8 inches. Round timber has of late years been used, as it is somewhat cheaper, and the round sticks are often split in two in making sets for drifts. The lower ends of the posts are simply placed on the floor without sills. A piece of lagging of proper length is usually wedged and nailed between the upper ends of the 2 adjoining sets to keep the sets apart and transfer the pressure of the ground against one set to the neighboring sets. The lower ends of the posts do not require this precaution, as they are set in the ground a few inches and so are firmly held.

The grade or inclination of the floor of the drifts or tunnels is about 1 foot in the hundred in all drifts following the vein, where they are usually very tortuous. Straight tunnels, adits, or crosscuts of greater length have an inclination of only 3 or 4 inches to 100 feet. All drifts or levels are provided with tracks of steel rails, joined by fish plates and resting on crossties of redwood 4 by 6 inches in section, 4 feet long. 90 per cent of all drifts and tunnels require timbering to prevent the caving in of the sides and roof.

The excavating of drifts and shafts is usually done by hand drills. The Santa Isabel and the Buena Vista shafts have been sunk largely by machine drills; so also all the long crosscuts underground.

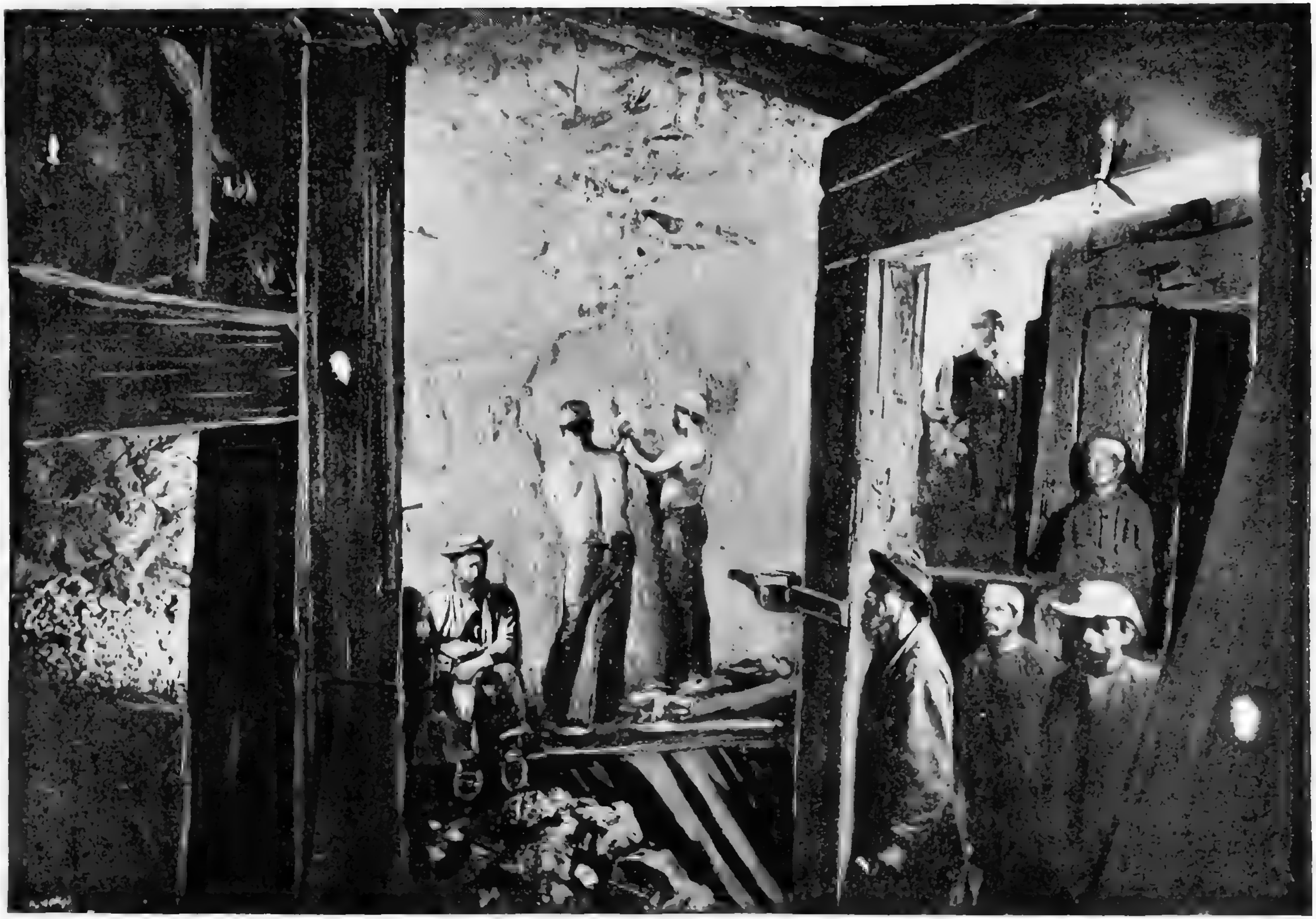
### ORE EXTRACTION.

The ore deposits having been reached by the drifts or crosscuts, their removal is accomplished in the following manner: The face of the vein rock is blasted out as far as the ore deposit reaches back into the vein, the floor being kept level with the drift. The deposits of cinnabar generally follow the hanging wall or alta, and vary in thickness from a few to many feet. As all the rock that contains cinnabar is broken out there is a large cavity left of irregular form, with sloping bottom and sloping, overhanging roof. The roof being formed of the hanging wall, which is mostly a shaly formation, is sometimes hard, but often very soft and clayey, and timbers have to be inserted for its support. The regular plan followed in stoping and timbering these ore excavations is by breaking the vein upward (overhead stoping) from the bottom of the level where the stope commences for a horizontal distance of about 4 feet, when, after squaring the face of the stope, the timbering, consisting of posts, caps, and lagging, is put in to secure the roof. In this way the ore is followed up as far as it reaches, and the timbering is continued as the excavation proceeds. The ore deposits being very irregular in form, it follows that the timbering is also very irregular in arrangement. A set of timbers usually consists of 2 legs or posts, a cap, and lagging, or, in very heavy ground, split timber, to support the roof. 2 auxiliary uprights or posts are put in place first, reaching from the bottom of the excavation to its roof and placed in a position normal to the pressure of the roof. Small channels from 4 to 6 inches deep, called "hitches", are cut in the foot wall for these auxiliary posts to secure them against the force of blasting. These posts are of different sizes, according to the nature of the roof, and usually 12 by 12, 14 by 14, or 16 by 16 inches thick. They are sawed off at proper lengths to reach the roof of the labor, against which they are tightly wedged. Parallel with the face of the labor they are usually 12 feet apart and 3.5 feet in the other direction. Against the inward side of these timbers, toward the face of the labor, the regular sets are placed, long enough to admit on the top the caps, which are also of heavy timbers from 12 by 12 to 16 by 16 inches thick, and on top of these caps, reaching from one set to the other, is placed the lagging or split timber to support the roof. In some cases 2 or 3 caps are laid on top of each other to support the heavy pressure of the roof, and the uprights sometimes consist of 4 posts, each 16 by 16 inches thick, bolted together with three-quarter-inch round iron bolts, forming a solid column of timber 32 inches square. Even this method is sometimes insufficient to withstand the great pressure, and solid cribwork of heavy timber has to be substituted to support the roof. Whenever possible waste rock is piled up in the form of pillars or walls, which, when well laid, is the best protection against pressure, although the steep slope of the ore bodies makes this method impossible in most cases.

The character of the vein is such that the ore can not be extracted without the aid of powder, and for this purpose, if possible, black powder is used, in order to prevent too much fracturing of the ore into very fine stuff. In very hard siliceous veins, however, dynamite powder is used; also when large fragments of rock have to be blasted, or in making room for timbers and in wet holes. The faces of the labores advance upward with a breadth of 20 to 50 feet, and if any ore remains at the sides it is taken up after the first stope upward has reached the level above, or it is taken up in steps all around as the work progresses. The main object is to keep a central place for the delivery of the broken ore into the cars, which would be more difficult if the whole face of the ore body were advanced upward at once. Pillars are not left in the ground, although with a very extended ore body (they are from 100 to 300 feet in length at times) it is usual to start the stopes from 2 or more places at once. The sorting of the ore is not done underground, excepting that large fragments of barren rock are left behind and piled up in places where they are out of the way. The filling in or stowing of the exhausted labores with waste rock is seldom resorted to on account of the irregularity of the stopes and the great expense incurred in tramming the rock to the required places. Old exhausted labores, however, are used as dumps for the waste rock from prospect drifts. The caving together of old labores, should it happen, does not cause any inconvenience, and most of the ground has been accessible after 10 years and over.

Two systems are employed in extracting the ore, (1) the footage system, and (2) the tribute system. The footage system is usually employed in new labores; that is, in such as have been recently discovered. The miners are paid by the depth of the bore holes drilled, the contract for each labor being awarded to the lowest bidder per foot. The number of men forming a company for 1 labor ranges, according to the size of the labor, from 4 to 20 or more. The men work in 2 shifts of 10 hours each, commencing work at 7 o'clock in the morning and 7 o'clock in the evening, respectively. These shifts are under the control of a foreman employed by the Quicksilver Mining Company. He is called the "blaster", and receives his orders from the mining captain. The blaster determines where the holes shall be drilled, in what direction, and to what depth. Beginning at the commencement of the shift and continuing for about 4.5 hours, each party of 2 miners will probably drill 6 to 8 feet of holes of 1.25 inches in diameter, or during the whole shift of 10 hours probably from 6 to 12 holes. The first part of the work is finished at about 25 minutes to midnight or midday, as the case may be, when a rest is taken for lunch. The blaster measures then the depth of all the drill holes and keeps a record of these figures, which constitute the earnings of the men. He hands to the men the powder can, and directs how much powder is to be used for each hole. After all the holes have been properly charged and tamped he gives the order to fire. The candle snuffs under each fuse are then lighted, and the men retire to a safe place. The number of blasts are carefully counted as they go off, so as to be sure that all charges have been exploded. In case a hole misses fire it becomes the duty of the blaster, after a delay of 30 minutes, to return to the drill holes and to find the unexploded charge. The hole is refired if it is found that the fault has been in the candle going out before setting fire to the fuse; but should the fuse have been burned without communicating the fire to the charge, then the hole is left untouched for 24 hours, and the men in the vicinity are warned to be careful. After 24 hours' time the charge is carefully picked out, and the hole is recharged and fired if necessary.

In the tribute system a company of miners, having selected some part of the mine to extract ore from, usually one of the abandoned stopes of former years, apply for a private contract to work it. They attend to all the different operations of mining, that is, stoping, drifting, blasting, and timbering, at an agreed price per ton of ore extracted. These contracts are given only for 1 month at a time and are renewed from month to month. The superintendent of the mine reserves the right to state the number of men that shall be employed in the work. The detail work is generally under the supervision of the mining captain, in order that the ground may be explored to the best advantage. The transportation is done by the Quicksilver Mining Company. Tools and timber are also furnished, the tributers supplying only powder and light.



STOPE OR "LABORE," NEW ALMADEN QUICKSILVER MINE.

### TRAMMING.

The waste rock from prospect drifts and winzes, crosscuts or upraises, if not used in filling up abandoned stopes, is brought in cars to the shafts where it is hoisted to the surface. The ore from the labores is transported in the same way. Care is taken to keep the ore separated from waste rock, and to keep separate the ores coming from the company's labores as well as those coming from the different tributers' labores, as the account of each tributer company must be kept distinct.

In the Randol mine, where many shifts of miners are working in prospecting or tribute work, and where many labores are being stoped, tramming is continued day and night. This work is awarded by contract to the lowest bidder per ton. A company of 4 or 6, sometimes 8, men takes the contract for tramming on several levels that can be worked together conveniently. In those parts of the mine where only 2 or 3 drifts or labores are being worked and the distances to be trammed are short the miners do their own tramming. In tramming, 2 men usually attend to a car that holds 1 ton of rock or ore. They fill the car at the ore stopes or at the pile of waste rock that has been thrown back by the miners.

On the 1,400-foot crosscut south from Santa Isabel shaft, which is over 2,600 feet in length, and in the Day tunnel, which is also of great length, the tramming is done by mules. The mules that work on the 1,400 crosscut from Santa Isabel shaft are stabled underground. The tramming from the Randol shaft on the 800-foot crosscut (adit) is done by mules to bring the hoisted material, ore, or waste rock from the shaft to the surface. 1 mule pulls a train of 2 cars, and is attended by a driver.

CARS.—Those used in the Randol mine are 5 feet 6 inches long inside the box, 2 feet 3 inches wide, and 1 foot 10 inches deep, holding from 1,600 to 2,000 pounds of rock or ore. The box is made of pine planks, the sides 1.5 inches thick, the bottom 2 inches thick, lined with quarter-inch sheet-iron plate on the inside. The upper edge is also protected by strap iron screwed on. The box has a hinged door in front hung on a 1-inch round bar of iron. This door is kept closed by a hook at the end of an iron bar which runs along the bottom of the car, and is opened or closed by turning the handle at the rear end of the car box. The trucks are made of 4 by 10 inch pine lumber, and provided with cast-iron wheels 14 inches in diameter. These cars dump only in front.

In the Day tunnel and the Randol adit (800 crosscut) cars of the largest size are used, as they are trammed by mules. These car boxes are also of wood, but measure inside 6 feet 2 inches in length, 2 feet 6 inches in width, and 2 feet deep. They have a capacity of 3,000 pounds. In construction they resemble the cars used in the Randol mine, except that they are provided with brakes worked by foot power from the rear end of the car.

At the Buena Vista shaft, where the cars are hoisted to the surface, they are made of three-sixteenth-inch sheet-iron boxes, 3 feet 8 inches long, 26 inches wide, and 2 feet deep. They dump in front or at the sides, as required. The truck is framed of timber and rests on 12-inch cast-iron wheels. One wheel of each pair is keyed to the axle, while the other revolves freely. The axles are of 1.25-inch round steel, revolving in cast-iron boxes. The cars weigh 600 pounds empty, and hold about 1,200 to 1,500 pounds.

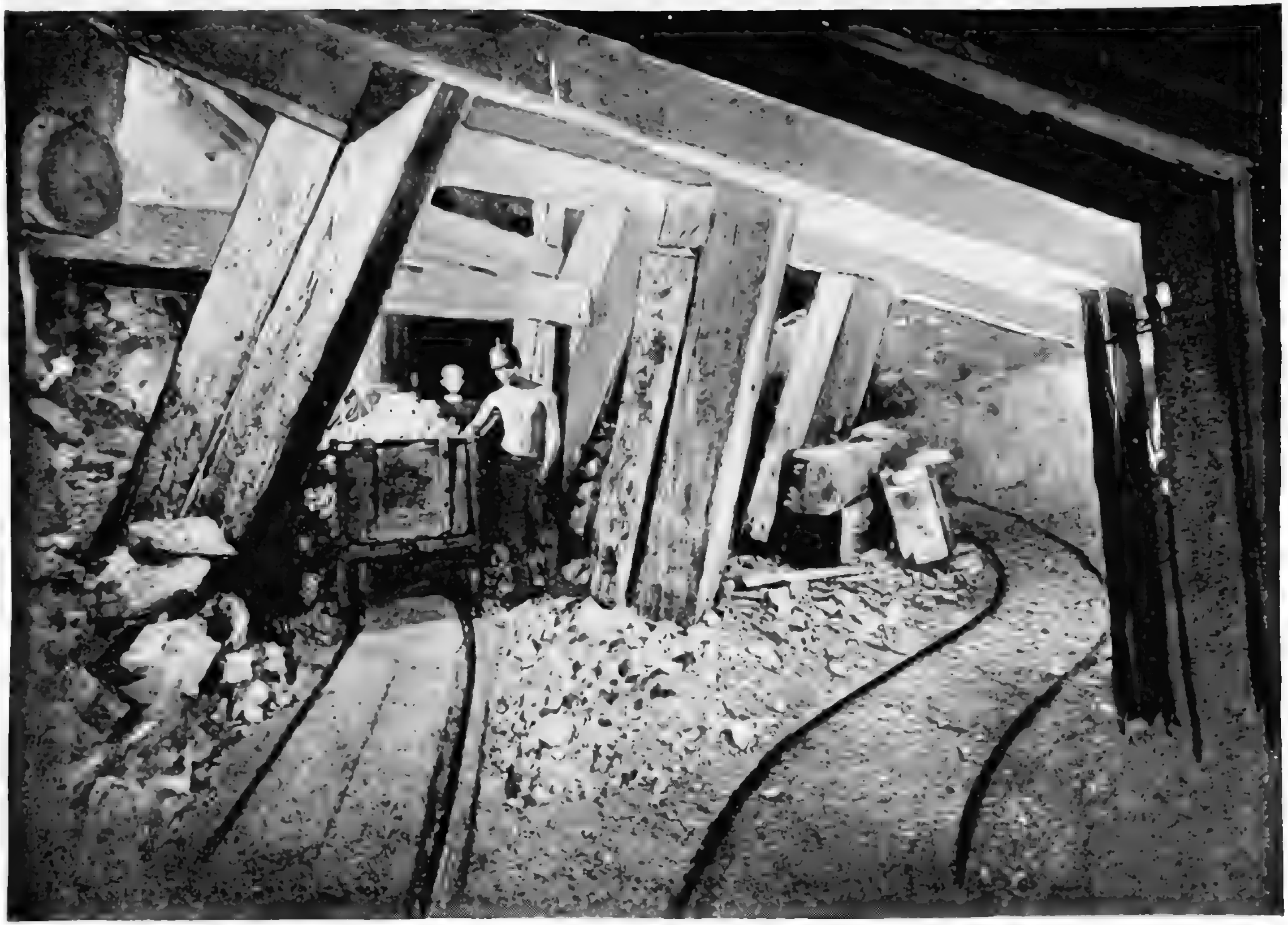
The gauge of the tracks is 24 inches in the Randol mine, 30 inches in the Day tunnel and Randol adit, and 20 inches in the Buena Vista, Almaden, Saint George, and San Francisco. One man, called the track layer, with an assistant, attends to all the laying and repairing of the tracks. The rails now used in the mine are of steel, weighing 12 pounds to the yard. The total length of all underground railroads, including the tracks leading from shafts to ore and waste dumps, is 35,000 feet, in round numbers.

HOISTING.—The ore and waste rock from the Buena Vista shaft is hoisted to the surface in cars on double-deck cages, provided with tracks for this purpose. There are consequently no dump plats in the Buena Vista stations. The cars while on the cage are held in place by hooks, which are dropped into staples riveted to each side of the car. All the other shafts are provided with skips for hoisting the ore and waste rock. The skips are rectangular boxes made of quarter-inch steel plates, stiffened at the corners by 2-inch angle iron, to which the sides are riveted by half-inch rivets driven from the inside. The inside dimensions of the horizontal section of the skip are 2 feet 8.5 inches by 2 feet 7 inches. The front side is 6 feet 3 inches long on the outside, while the rear side is only 3 feet 7 inches long, which gives the skip a sloping bottom. The lower end of the front has a hinged door 2 feet 4 inches high, covering the whole width of the skip. This door is closed by a latch bar 3 inches by five-eighths inch extending across the front and dropping into catches projecting from each side of the box, and is kept locked by a movable key or pawl which hangs above it. A piece of angle iron riveted to the bottom of the box, on the outside near its front edge, serves for a shoulder to rest against the apron or door of the shaft while unloading. The guide frame or bale of the skip is made of three-quarter-inch iron, 4 inches wide, riveted to the sides of the skip by rivets driven from the inside of the box. The transverse bar on the upper end of the frame or bale is of wrought iron 1 inch thick and 3.5 inches deep, with flanges at each end and bolted to the guide frame. From the transverse bar down along each side of the frame to the lower end of the skip box extends a guide strap 4 inches wide, one-fourth inch thick, fastened to the frame and skip box 1.25 inches from the face of the box, which brings the outside faces of these guide straps 2 feet 11.5 inches apart and leaves one-half inch for play between the guide rods. Near the upper and lower ends of each guide strap shoes are fastened to the frame and skip box, made of iron three-eighths inch thick, 6 inches high, the 2 flanges or checks of each shoe extending 2.75 inches beyond the face of the guide strap. The inner faces of the flanges are protected by false plates riveted to the shoes. The inner surfaces of each pair of plates when worn down are easily replaced. A drawbar 2.25 inches in diameter passes through the upper end of the bale or frame. It has a vertical play of 9 inches, and is prevented from turning by a key. To the lower end of the drawbar double nuts are screwed to hold it within the frame, while 2 nuts on the upper end hold the clevis to which the shackle is attached. The top of the guide frame is covered by a bonnet or hood of three-sixteenths-inch sheet iron, fastened to the frame by bolts. The bonnet has hinges at the distance of 6 inches from its ridge, to allow its being opened if necessary. The skips are provided with a safety arrangement, alike on all skips and cages except the timber cages, which are without it. The arrangement referred to consists of 2 round steel bars, 1.5 inches in diameter, extending across and beyond the frame of the cage far enough to embrace within their ends the guide rods, also called "skip rods", which are sticks of timber 3.75 inches square, planed, and fastened to each side of the shaft, extending from top to bottom. On the ends of the round steel bars are placed and keyed fast cast-iron eccentrics having a serrated surface on a part of their circumference. The bars are supported by and revolve freely in eyes forged on each side of the upright members of the frame of the skip or cage. A chain pulley is keyed to each bar at the center, to which a three-eighths-inch chain is made fast, passed around it, and attached to the drawbar or lifting bolt. The length of this chain is such that when the drawbar takes the weight of the cage it causes the shafts carrying the eccentrics to partly revolve, bringing the smaller radii of the eccentrics opposite each other. As there are no teeth on this part of the circumference of the eccentrics, there is sufficient space left between to clear the wooden guide rods. The bars while turning into this position act on 2 strong steel spiral springs, 1 on each side of the corresponding eccentric, drawing their coils closer together and exerting a force of several hundred pounds. The moment the strain is removed from the drawbar or lifting bolt, in the event of resting the cage or skip on some support, or in case of the suspending rope parting or breaking, the springs uncoil with sudden force, turn the shafts or cam bars, and bring the greater radii of the 2 opposing eccentrics closer together, their teeth grasping the wooden guide rods with stronger force the heavier the attached weight, and preventing the skip or cage from further descent. The weight of these skips complete is 1,700 pounds. Their capacity is 3,000 pounds of rock. Skips of the same size are used at the Santa Isabel shaft. Shafts with small hoisting engines have skips of proportionate size, holding 2,000 or 1,000 pounds only, but the construction is similar to those of the largest size, and all are provided with safety attachments. For hoisting water, self-dumping skips, working automatically, have been used at the Santa Isabel and Buena Vista shafts.

For hoisting and lowering men at the Randol and Santa Isabel shafts double-deck cages are employed. They contain 2 platforms or floors 2 feet 7 inches square, made of quarter-inch sheet iron, 6 feet apart, hanging by 4 round iron bars, 1 inch in diameter, from 2 bars that are fastened to the guide frame with three-quarter-inch bolts. These cages are provided with bonnets and safety clutches. Each deck holds 6 men. To send timbers into the Randol mine a cage with a single platform and without bonnet or safety apparatus is used. The guide frame is 8 feet long and 2 feet 8 inches square. The cage at the Buena Vista shaft is similar to the one used for men at the Randol shaft. It has in addition track irons on each deck for the cars. This double-deck cage weighs 1,800 pounds.

The Buena Vista shaft is provided at the top and at the 2,100-foot station with landing chairs to support the cage while the cars are run off or on the platform of the cage. They consist of 4 wrought-iron knees, 2 on each side of the shaft, into which they project, and are situated just below the floor of the station. They are withdrawn from projecting in the shaft by a lever keyed to the shafts, which are connected with the knees by iron rods. By moving the lever backward the shafts partly revolve, withdrawing the knees and leaving the way clear for the descending cage. The "lander" or station tender operates this lever, a catch being also provided to keep the lever in position when withdrawn, if required. Automatic covers close the top of the Buena Vista shaft when the cages are down.

The rock and ore from the mine are hoisted at the Randol shaft to the 800-foot adit level, and thence run out in cars drawn by mules, as already mentioned. This adit level, or 800 crosscut from the Randol shaft, is 700 feet long. From the mouth of the crosscut begins an elevated car track, which leads to the planilla or ore-cleaning shed and to the waste dump. At the 800-foot station a sheet-iron door or apron, movable on hinges, is secured against the open side of the shaft in such a way that by the movement of a lever the upper edge of the apron will project about 4 inches inside of the shaft, while the lower edge will project outside and over the top of a car that stands in place on the track alongside of the shaft. The loaded skip having been hoisted a couple of feet above this 800-foot station, the apron is brought into position by the lever, and the skip is lowered down until it rests with the angle iron on its bottom against the upper edge of the apron. The skip door is then opened by throwing aside the key or pawl and swinging the latch bar from the catches, when the whole charge drops into the ready car. 1 man at the station attends to this work. 2 cars make a train, which is drawn by a mule, attended by a driver. A loaded train is taken out and the empty cars returned while another train is filled by the man at the station. A switch track at the station gives room for the management of the trains. The loaded train, having arrived at the mouth of the adit, is taken in charge by a man called the "car dumper". He pushes the cars to their destination and dumps the loads at the different screens when loaded with ore, or discharges them over the waste dump if they contain waste rock, called "tepetate". In this way the work goes on without interruption day and night.



TRAMMING, 1,500-FOOT LEVEL, RANDOL SHAFT, NEW ALMADEN QUICKSILVER MINE.

At the other shafts, where the ore or waste rock is brought to the top of the shaft and where the cleaning floors for ore and the waste dump are near at hand, the discharging of the skips and the tramming of the loaded cars, etc., is done by 1 man, called the "lander", using only 1 car, which can be discharged while another skip load is being hoisted to the surface.

The arrangement for loading skips at the different stations of the Randol and the Santa Isabel shafts is as follows: Filling the skips with the material to be hoisted from the Randol shaft is done by contract. The prices for skip filling range from 8.5 to 10 cents per ton. 6 men at the Randol shaft form a company, who attend to all skip filling at the different stations of that shaft. At other shafts, where less rock is hoisted, skip filling is done by day's labor. The stations at all the shafts excepting the Buena Vista are of 2 stories. In the Randol and Santa Isabel shafts a dump car is used for filling the skip. This car stands on the lower platform, on a short track facing the shaft. It is made entirely of iron and holds exactly 1 full charge for the skip, or 3,000 pounds. The dump car is of the same size as the skip. The car is open in front, a short board being placed in the forward end to keep the rock in place while the car is being filled. The forward end of the rails that form the track are bent upward, so that the car can be pushed only a short distance ahead, just sufficient to overhang the skip ready for the load. The advantage of this dump car is that the skip fillers can prepare the load while the skip is being hoisted and lowered again, and a charge is ready by the time the skip returns to the station. The dump car is then run forward on its short track and its charge dumped into the skip. To hold the skip in place while being filled and to relieve the hoisting rope from the sudden shock of the falling load a bar is placed in the shaft, which is held at one end by a bolt run through an eye in the bar at one end, and through 2 stationary ring bolts fixed to the side of the shaft nearest the station, while the other end of the bar is allowed to drop against the rear side of the shaft, the bar being of such length as to lay at an angle to suit the sloping bottom of the skip. In shafts that are not provided with dump cars skips are filled by shoveling.

LIGHTING THE MINES.—For lights candles are used. The trammers often prefer to use small lamps burning fish oil, as they better withstand the draft. The shaft houses are lighted up at night by large headlights that throw a strong light against the gallows frame and upon the hoisting rope.

VENTILATION.—All the different levels of the mine are connected by the shafts and winzes, which insures the free circulation of air through all its workings. In long crosscuts and drifts remote from the main air currents the air at times becomes hot and vitiated and artificial ventilation is necessary. This is usually accomplished by doors, which force the air current to take a certain desired direction, or by wooden boxes or sheet-iron pipes so arranged that the air is compelled to pass through these conduits toward the face of the drift. Where these means fail, blowers or fans, in connection with wooden boxes or sheet-iron pipes, are used. Blowers for small drifts, upraises, or winzes are driven by hand power. When a greater or more constant volume of air is needed, these fans or blowers are driven by engines, worked by steam only when the power is applied on the surface. For underground power compressed air only is used. As nearly all the underground workings are connected by the different shafts, the natural ventilation takes place by upcast or downcast currents, aided by the different adit levels.

The main tunnel (300 level) of the old mine connects by winzes with all the upper workings above that level, and by an interior shaft, the Main shaft, with all levels down to the 600-foot level, and thence by the Junction shaft, also an interior shaft, with the 800 level, or Day tunnel. The Day tunnel connects with the Washington shaft, and by a branch drift with the Randol shaft. The Washington shaft connects on the 1,100 level by an incline with the 1,400-foot level of the Santa Isabel shaft. The Santa Isabel shaft connects on the 1,400 level with the Randol mine, and through upraises with the Saint George shaft. The 1,700-foot level of the Santa Isabel connects by a long crosscut with the Randol shaft, and by an incline shaft the 1,900-foot level of the Santa Isabel is also connected with this crosscut (1,700). The Randol shaft connects through a winze from the 1,900 level with the 2,100 level, Buena Vista. The 2,100-foot level of the Buena Vista and Santa Isabel are also connected. The adit to the Randol shaft, or 800 crosscut, aids also in the ventilation, so also does the adit or water tunnel on the 1,200 level, Buena Vista. The levels from the different shafts are also connected by numerous winzes, and partly also by passages through some of the old ore stopes.

The Santa Isabel shaft is a downcast shaft (collar 728 feet below datum), and acts so at all times. The Buena Vista shaft is always upcast (collar 885 feet below datum), taking the current of air from the Santa Isabel. Part of this current comes through the Buena Vista shaft to the surface; another part ascends through the 2,100-foot incline into the Randol workings.

The Randol shaft, 426 feet below datum, acts at all times as an upcast shaft from the bottom level (1,800-foot level) to the 800 adit or crosscut. The air current through the 800 adit, or crosscut, of the Randol shaft changes its direction according to the state of the weather on the surface. On cold days the current rises in the shaft and the air comes in through the crosscut, while on warm days the current is reversed.

The Randol shaft takes the air current from the 2,100 level, Buena Vista, as already mentioned, from the Santa Isabel through the 1,700 crosscut mainly, and also from the incline shaft connecting the 1,700 crosscut with the 1,900 level, Santa Isabel. The Saint George shaft, 570 feet below datum, is an upcast shaft, taking the current from the Randol shaft and partly from the Santa Isabel shaft. The Washington shaft, 176 feet below datum, is an upcast shaft in cold weather and downcast on warm days. The air current passes out of the Day tunnel on warm days, and reverses on cold days. So also acts the current of air in the incline connecting the 1,100 level of the Washington shaft with the 1,400 level, Santa Isabel, being downcast on warm days and upcast on cold days. These shafts and tunnels form the main arteries for the ventilation of the whole mine.

## TEMPERATURE.

The temperature at different points in the mine is naturally much influenced by the air currents. The 1,700 crosscut which connects the Santa Isabel shaft with the Randol shaft is the coolest part of the deep underground passages. It averages 60° fahrenheit in summer and 50° in winter. The highest temperature observed in any part of the mine was 88.5° fahrenheit. Some observations gave the following data (the degrees are fahrenheit):

SANTA ISABEL SHAFT.—On December 14, 1888, the temperature at the surface was 55°. At the 1,400 station, near shaft, 575 feet below surface, it was 58°. In the 1,400 crosscut from this shaft, at a point 800 feet distant from the shaft, it was 78°. At the face of the 1,400 drift south from the crosscut, at a distance of 2,600 feet from the shaft, with ventilation through air boxes 10 by 20 inches in section, the observed temperature was 85°. It must be noticed that this observation was taken while the drift was being worked, as the temperature is much less after only 12 hours interruption of the work. In the 1,400 level west (a branch of the 1,400 crosscut) and about 550 feet distant from a winze coming up from the 1,500 level of the Randol shaft, the drift being supplied with air by an 11-inch pipe, the observed temperature was 84°.

SAINT GEORGE SHAFT.—On December 14, 1888, the temperature at the surface was 55°. At the 1,000 level, near station (386 feet below surface), it was 76°. The Saint George shaft acts as an upcast shaft. At the 1,200 level, in an upraise 20 feet above the drift, it was 82°. This observation was taken while the upraise was being worked. The point was remote from shaft or winze and had no artificial ventilation.

RANDOL SHAFT.—On December 13, 1888, the temperature at the surface was 51°, the weather rainy. At the 1,300 station, near shaft (826 feet below collar), the temperature was 72°. At the 1,300 level, in an upraise 20 feet above the level and 1,200 feet distant from the shaft, the temperature was 77° while the upraise was worked. At the 1,400 station, near shaft (925 feet below collar), it was 75°; at the 1,400 level, at a point 500 feet north from the shaft, 76.5°; at the 1,400 level, at a point 800 feet north from the shaft, 78°, and near the same place, standing in the air current, coming up from a winze, the temperature was 76°. At the face of an upraise from the last observation point, and at about 30 feet above the level, the observed temperature reached 86°. This upraise was then being worked. At the 1,500 level, in an upraise about 1,500 feet distant from the shaft and about 40 feet above the level, the temperature reached 88.5° while the miners were at work. On the 1,600 level, west of the shaft about 1,000 feet and in good air current, the temperature was 73°. At the 1,600 station, at shaft, it was 74° (1,125 feet below surface), while the temperature on surface was 54°.

For ventilating purposes there are on hand 1 No. 2 and 1 No. 3 Baker rotary pressure blower, 1 Root blower, and 1 Blackmann power ventilator and exhaust wheel of 5 feet diameter. For special purposes exhaust fans are constructed similar to the Guibal fans of old construction. One of these fans, 12 feet in diameter, had been erected at one time over the Washington shaft for the purpose of regulating the ventilation on the 1,400 crosscut from the Santa Isabel shaft, while much carbonic-acid gas was present, and very satisfactory results were obtained with small cost. The fan was driven by a small steam engine of 6 horse power. All the communications with the Washington shaft were closed except the one with the 1,400 crosscut, Santa Isabel.

The length of drifts, winze, and shaft which this current had to pass through was: 1,400 crosscut to foot of incline, 2,490 feet; length of incline (235 feet perpendicular elevation), 300 feet; 1,100 level, Washington, 950 feet; shaft to the surface, 865 feet; or a total of 4,605 feet. The air in the 1,400 crosscut was mixed with carbonic-acid gas to such an extent that a lighted candle would go out almost instantly, and the natural draft was insufficient to set the column of heavy air in motion. The 12-foot exhaust fan was started on May 23, 1888, at noon, the fan making 40 revolutions per minute, and at 2 o'clock the same afternoon the air in the crosscut was found pure. The exhaust flue had an area of 19.125 square feet (perimeter 17.5 feet); the velocity of the exhausted air, measured by Cassell's anemometer, was 682 feet per minute.

For ventilating short drifts or crosscuts small ventilating fans of 18 inches diameter and 8-inch face are used, driven by a 6-foot wheel moved by hand power. Boys are employed for this purpose. The air is carried to the face of the drift by 8-inch sheet-iron pipes.

## DRAINAGE.

The water from all underground workings below the 800 level is conducted to the Buena Vista shaft, where it is pumped to the adit or drain tunnel, and through this tunnel reaches the surface. The amount of water raised is small when the large area of the underground workings is taken into consideration. The part of the mine controlled by the Randol shaft, from the 800 level down to the 1,800 level, is almost dry, and the small quantity of water which collects in the sump is pumped out once a week by a hand pump and the water conducted in a pipe through the 1,800-foot level toward a winze which connects with the Buena Vista shaft. The workings above the 800 level are drained by the Day tunnel and the Randol crosscut. From the Washington shaft the water is drained by a siphon down the incline from the 1,100-foot level into the 1,400 crosscut of the Santa Isabel shaft. From the 1,400 station of the Santa Isabel shaft the water is carried by an inverted siphon, made of a 4-inch pipe, down the shaft to the 2,100-foot level, and along that level to the Buena Vista shaft, and up to a tank 193 feet below the adit tunnel, and thence raised by the pump. The water from the lower workings of the Santa Isabel shaft drains into the Buena Vista shaft, and with the water from other parts of the Buena Vista workings is pumped to the surface. The Saint George shaft drains into the Santa Isabel workings. The Almaden shaft is drained by hoisting the water in buckets.

Buena Vista pumping engine.—The pumping engine at the Buena Vista shaft is of the compound direct-acting rotative type. The cylinders are placed directly over the main beam or bob, and in line with it. The initial cylinder piston is connected by means of rods, and slides to the pin nearest the fly wheel, the expansion cylinder piston being connected to the beam in the same manner, between the initial cylinder and the beam trunnions. The total lift is 890 feet, including the sump. The pump work in the shaft is on the Cornish system, and consists of 8 plunger pumps, 2 of which are placed at each of the 4 stations, with a single spear passing between them. In addition to these pumps is the one stationed 193 feet below the adit tunnel. The water comes to this pump from the 1,400 level of the Santa Isabel shaft through a 4-inch pipe 3,000 feet long and discharges 75 gallons per minute into the supply tank.

The pump stations are 10 by 18 feet in size, and situated at distances varying from 205 to 237 feet perpendicularly above each other. The tanks on these stations have each a capacity of 2,400 gallons. The pump stations are at 499 (193 below adit), 543, 743, 971, and 1,171 feet below collar of shaft. The bob stations are 384, 634, and 1,062 feet below collar. Each pump discharges through an 8-inch column into station above. The column is made of 8-inch lap-welded wrought-iron tube, joined at the ends by cast-iron flanges fitted on the tube and secured by expanding it to fill the bore of the flange tightly and in a manner to prevent telescoping. The spear, or pump rod, is of Oregon pine, 1,160 feet long, in sections of 50 feet. The first 600 feet of this rod are 12 by 12 inches in section, the remainder being 10 by 10 inches. The joining of the sections is effected by butting the ends evenly and closely together and securing them in position by placing wrought-iron strapping plates 20 feet long, 8 inches wide, and 1 inch thick on each of the 4 sides of the rod, the joint being in the middle of their length, and bolting through rods and straps with 40 1-inch bolts, one-half passing the other at right angles. The pump plungers are connected to pump rod by cast-iron brackets securely bolted to 2 opposite sides of the rod and engaging with flanges on the ends of the plungers. To provide against lateral motion of the rods they are stayed at each 50 feet of their length by inclosing them in wooden guides, the rod at such places being lined with oak boards secured by iron clamps. The balance bobs are 3 in number, made of cast iron, with wrought-iron tension straps. They are each connected to the pump rod by wrought-iron links or connecting rods 15 feet in length, with brass journal boxes and straps on each end. They are hung from 2 wrought-iron pins in nose of the bob, the lower end engaging with pins in 2 cast-iron brackets bolted to 2 opposite sides of the pump rod. The bob stations are 30 feet long, 12 feet wide, and 18 feet high, secured by 14 by 14 inch timbers; so also are the pump stations. The first is 383 feet from the surface, the second 250 below the first, and the third 428 feet below the second. A 9-inch lift pump is used to raise water from the sump to the plunger pumps on the 2,100-foot level, the difference in capacity between the 2 8-inch pumps and the lift pump being supplied by the flow of water in the 2,100 level, which also receives any excess over 75 gallons per minute from 1,400 level at Santa Isabel shaft.

The pumps described raise 315 gallons per minute, making 8 double strokes in that time. It would be 360 gallons per minute if the supply pipe to pump taking water from 1,400 Santa Isabel shaft was large enough to admit of a supply of 120 gallons per minute, which is the amount required to supply that pump at 8 strokes per minute. The stroke of the pump is 6 feet.

The pump rod is actuated, as already mentioned, by an under-beam compound condensing steam engine with Scott & O'Neil balanced puppet valve and cut-off motion. The cylinders are placed side by side on a heavy bed plate, and to the bottom of this are bolted the guide plates for the crossheads. The cylinder of the high-pressure engine is 21 inches in diameter and has a stroke of 96 inches. The expansion cylinder is 47 inches in diameter, stroke 70 inches. The connecting rods of each engine are connected directly to one end of the beam and pump rod to the other end. The initial engine, being on the outside, has a longer stroke and greater piston speed than the expansion engine, which is placed nearer the center of the beam. The beam is made of cast iron, the arms of which are securely tied by wrought-iron straps 10 by 2 inches in section. The main connecting rod connects an angle arm of the beam to a wrought-iron crank and shaft, on which is placed a fly wheel 24 feet in diameter, weighing 50,000 pounds. The valve motion is derived from a shaft running at right angles to the crank shaft and operated by a miter wheel.

The air pump and condenser are of a special kind on account of the small quantity of water available. The condensation water falls from the condenser through an 8-inch pipe to a tank placed 35 feet below it. The end of the pipe is 3 feet below the water surface in the tank, sealing it against the atmosphere. A small independent bucket-and-plunger pump maintains the vacuum in condenser. The condensation water flows from the tank receiving it through a flume 1,850 feet long and 2 feet wide, passing in its circuit through a pond 25 by 50 feet, and discharging into a tank a few feet from and about 6 feet lower than the first tank. A pump placed in the shaft at this point raises the water, discharging it into a tank on the surface, when it again passes through the condenser, it having been sufficiently cooled in its circuit through flume and pond, the cooling surface of which is nearly 5,000 square feet. The engine is also provided with an automatic stop, which throws the valves out of connection and instantly stops its motion if through any accident it should be relieved of all or any considerable part of its load.

The foundation is built of hewn sandstone, with cap stones of granite. The pump work is handled, when necessary, by a double-cylinder horizontal geared hoist, set on stone and granite foundation.

The cylinders are 12 inches in diameter, with stroke of 24 inches. The reel and spur wheel are bolted together and keyed on same shaft. The spur wheel is 12 feet 1 inch in diameter, with V-shaped teeth, 3.25-inch pitch, and 12-inch face and gears, with a pinion 2 feet in diameter on crank shaft of engine. The reel is 3 feet in diameter, and constructed for winding flat rope. The engine is fitted with a closed link and reversing lever, Corliss throttle valves, and a powerful Eckhardt stand brake, applied on engine fly wheel. The rope used is flat crucible steel wire rope 4.5 by 0.5 inch, 2,000 feet of which can be wound on the reel if desired. The rope in use is about 1,600 feet long.

SANTA ISABEL PUMPING WORKS.—The pumping plant at Santa Isabel shaft consists of 6 6.5-inch plunger pumps and 4 6-inch pumps, all having a stroke of 5 feet.

Of the 6.5-inch pumps 2 are placed at the 1,700, 1,400, and 1,000 foot levels; of the 6-inch pumps 2 are placed at the 1,900 and 2,000 foot levels. They are actuated by 2 pine rods 6 by 8 inches in section, 1,230 feet long, in 50-foot sections, and connected in the same manner as those at Buena Vista shaft. They are connected to 2 right-angle bobs on the surface, arranged so that one rod is ascending while the other is descending. In this way one rod balances the other, and as the water flows through the column on both up and down stroke, 1 discharge column only for the 2 pumps is required. There is 1 balance bob attached to each rod to relieve the surface bobs of some of the weight of the pump rods. The column is made of 6-inch lap-welded wrought-iron tube, connected by threaded ends and screwed into connecting sleeves. Part of the column, however, is connected by cast-iron flanges.

This pump work is operated by a compound condensing engine, the high-pressure cylinder being within and concentric with the low-pressure cylinder, the piston of which is an annular ring 42 inches in diameter outside and 26 inches inside. The high-pressure cylinder is steam jacketed, 19 inches in diameter, with stroke of 5 feet. The steam distribution is effected by a double-ported slide valve controlled by Davey differential valve gear. The air pump is driven by an extension of the high-pressure piston rod. It is 9 inches in diameter, 5-foot stroke, and is situated directly behind the steam cylinders. The engine frame is extended to connect with sole plates carrying the bobs operating the pump rods. They are of cast iron, with tension straps of wrought iron. The pit work is handled, when required, by a capstan situated near the shaft house.

A third pumping plant, not now erected, consists of a horizontal noncondensing engine, having on the crank shaft a pinion gearing with a spur wheel, on the shaft of which is keyed a disk with wrist pin. The disk has in its face 4 holes at varying distances from its center, into any one of which the wrist pin may be put, giving a stroke varying from 2.5 to 4.5 feet. This wrist pin is connected by a wooden connecting rod strapped with iron to an angle bob to which pump rod is attached. The bob is constructed of wood, with iron straps, and fitted with a balance box, wherein weights may be placed to equalize load on the engine. The gear wheels are 2.375-inch pitch and 9-inch face; ratio between pinion and spur wheel as 1 to 7.

The pumps in the shaft are to have 6-inch plungers, the stroke varying with the position of the wrist pin in the disk or crank plate operating the angle bob. The spear rod is 6 inches square, to which the plungers are secured in a different manner from those described at the Buena Vista shaft.

The plunger is of iron, cast hollow, and about 1 inch in thickness. A suitable piece of timber, considerably longer than the plunger, is made to fit tightly inside of the hollow tube, and after being driven in is tightly wedged in place. The timber projecting beyond the plunger is square in section and clamped to the pump rod, a distance piece being introduced between them to bring the plunger to the desired distance from the rod. There are 2 plunger pumps and 1 lift pump still remaining as part of the pit work, operated by the machinery just described, the capacity of which is 50 to 60 gallons per minute from a depth of 1,000 feet; speed in shaft, from 3 to 12 strokes per minute.

The Santa Isabel pumps will discharge 170 gallons per minute from a depth of 1,500 feet; speed in the shaft, from 1 to 10 strokes per minute.

The Buena Vista pumps will discharge 315 gallons per minute from a depth of 1,800 feet; speed, from 2.5 to 8 strokes per minute. The average speed at Buena Vista pump works at present is about 4 strokes per minute.

In addition to the regular pumping machinery there are available for mine drainage 4 steam pumps, 2 of which are of a capacity of 80 gallons per minute, 1 of 40 gallons, and 1 of 50 gallons capacity; also 2 bailing tanks, holding 500 gallons each, and 2 other tanks, each carrying 120 gallons.

### HOISTING WORKS.

BUENA VISTA SHAFT.—The hoisting machinery at the Buena Vista shaft consists of 2 horizontal noncondensing engines, with balanced puppet valves with O'Neil cut-off motion, reversing link, and Corliss throttle valves.

The engines are connected by and act on the same crank shaft. 2 reels, to which brake wheels, 10 feet in diameter and 8-inch face, are attached, are placed on the crank shaft, and are free to revolve in either direction and independent of each other. They may be made to revolve with the shaft by throwing into gear 2 clutches sliding on the shaft (it being square in section at these places) and revolving with it. The reels may be used singly or together, and by winding the ropes on the reels in opposite directions one may be made to hoist while the other lowers, using the descending cage and rope as a counterweight. Flat steel wire rope is used, 3.5 inches wide and three-eighths of an inch thick. The length is 1,600 feet. Each reel is provided with a powerful Eckhardt brake, operated by the foot. An iron brake strap lined with wood is also employed, acting on the crank disks, which are 8 feet 10 inches in diameter and 6-inch face. This brake acts on the engine, or either reel or both, if the clutches on the shaft are engaged with them.

A Behr spiral indicator shows position of cages in the shaft. This indicator consists of a drum 39 inches in diameter, 4 feet 6 inches long, revolving with its axis vertical behind a pointer, to which a vertical motion of 2.375 inches for each revolution of the drum is communicated by an upright screw, revolving by the side of the drum. The vertical motion of the pointer, combined with the circular motion of the drum, traces a spiral line on its surface, the length of which is about one-tenth of the depth of the shaft. On this line are placed brass plates showing the different stations and the number of bells constituting the signals for the stations.

A second pointer, moving against a stationary index board, is also provided. This is always in the engineer's sight and lessens the liability of his confusion by reason of the revolving drum carrying the station marks out of his sight during the greater part of its revolution.

These indicators are driven by gear wheels, one on each reel and in permanent connection with it. The 2 reels are set opposite the 2 hoisting compartments in the shaft and are situated 50 feet 6 inches from it. On the platform from which the engine is handled there are 5 levers, 1 for throttle valves, 1 for reversing the engine, 1 for adjusting the cut-off, and 2 for operating clutches. The 3 pedals for operating the brakes are side by side, and they, with the first 3 levers, are within reach of the engineer without changing his position. The foundation is built of sandstone, with granite cap stones. The gallows frame consists of 2 perpendicular frames of 18-inch timbers, 1 at each end of the shaft, 45 feet high, standing on sills 55 feet long. The frame is 18 feet wide, from outside to outside, and stiffened by horizontal beams and braces. Each frame is secured against the thrust by inclined beams 16 by 20 inches thick, and 50 feet 9 inches long. The 2 frames stand 32 feet 6 inches apart, from outside to outside, and are connected by bridged trusses of 18-inch square timbers, supported by struts 12 by 18 inches. The horizontal beams on top and crossing from one frame to the other are 18 by 24 inches. The sheaves are carried on 14-inch timbers, 2 on top of each other at each side of the sheaves.

The overhead pulleys or sheaves are 9 feet in diameter (center 48 feet above floor), with rims of cast iron and wrought-iron arms. The speed of hoisting is from 1,000 to 1,200 feet per minute in the shaft. The load, including 1,000 feet of rope, is 9,000 pounds.

Each compartment of the shaft has a separate bell for signaling. The bell cord is of three-eighths inch galvanized twisted iron-wire rope, and can be reached from the cage in any position in the shaft.

The boilers at this shaft are 6 in number, set in pairs over 1 furnace. They are each 54 inches in diameter and 16 feet long, with 46 3.5-inch tubes. Each pair is connected by 1 mud drum and 2 steam drums. A 6-inch safety valve is placed on each steam drum, 2 of which are also fitted with Crosby adjustable safety pop valves. The main steam pipe is 10 inches in diameter, with 6-inch branches to the hoisting engine and pumping engine.

SANTA ISABEL SHAFT.—The hoisting machinery at Santa Isabel shaft is a single horizontal high-pressure engine, cylinder 16 inches in diameter, stroke 36 inches, with balanced slide valve and reversing link.

On the crank shaft are 2 pinions, free to revolve on it, and 2 clutches revolving with it, the latter sliding on 2 feathers to engage with either or both of the pinions. There are 2 reels, 1 for each hoisting compartment in the shaft, each 10 feet in diameter and 20 inches wide, having a spur wheel and brake rim cast on one side, the spur wheels gearing with pinions on the shaft. The wheels are 11 feet in diameter, pitch of teeth 3 inches, and 8-inch face. Ratio of wheel to pinion is as 4.5 to 1. Round steel-wire ropes 1.125 inches in diameter are wound on the 2 reels, and in opposite directions to admit of hoisting with balanced load. 2 dial indicators show position of cage in the shaft, the index pointer traveling about 10 inches for every 100 feet traveled by the cage in the shaft. Each reel is provided with a stand brake, the shoes of which are lined with sugar pine. A powerful iron band brake is also applied on the engine fly wheel. The 3 brakes are operated by the foot and one of them is so arranged that hydraulic power can be applied to it. The one last referred to is on the reel working opposite the middle compartment in the shaft, it being the one used when sinking is done in the shaft. The gallows frame is 32 feet in height, built of 14 by 14 inch timber in the form of a truncated pyramid 30 feet square at the base and 18 by 15 feet at the top. Overhead pulleys are 9.5 feet in diameter, the rim grooved for rope of 3.5 inches in circumference.

The machinery is set in a massive foundation of artificial stone, the center of reels being 48 feet from the shaft. The boilers are 4 in number, set in pairs, 2 having separate furnaces and 2 being set over one furnace. The latter are connected by 1 mud drum and 1 steam drum, the former by 1 mud drum, but having separate steam drums. Of this pair, each is 56 inches in diameter and 16 feet long, with 48 3.5-inch tubes. The other pair is built of steel, each 54 inches in diameter, 16 feet long, and having 46 3.5-inch tubes. A 4-inch safety valve is fitted to each steam drum. The boiler feed water is heated by exhaust steam to the boiling point before entering the boiler.

The hoisting speed at this shaft is from 600 to 800 feet per minute. The load, including 1,000 feet of rope, is about 6,700 pounds.

RANDOL SHAFT.—The hoisting gear at the Randol shaft consists of a high-pressure horizontal engine, cylinder 16.5 inches in diameter, the stroke being 30 inches.

1 reel, 9 feet in diameter, 25-inch face, is keyed on the spur-wheel shaft, the spur wheel being driven by a pinion on the crank shaft. These wheels have V-shaped teeth, 3-inch pitch and 10-inch face, ratio about 4.5 to 1.

The pointer on the indicator has a vertical motion of 3.25 inches to 100 feet in the shaft, the direction of its motion being the same as that of the cage in the shaft. It is operated by a vertical screw driven by bevel gears, which derive their motion from reel shaft. The reel is fitted with a stand brake, which is applied by releasing a weight acting on a lever, drawing the brake block together and against the reel. A foot brake is also applied to the fly wheel of the engine.

The speed of hoisting is from 500 to 600 feet per minute. The load is the same as at the Santa Isabel shaft. A round steel-wire rope is used, 3.5 inches in circumference (1.125 inches in diameter). The gallows frame is 28 feet high, built of 12 by 12 inch timber, of the truncated pyramid style, 24 feet square at the base and 11 feet at the top. The overhead pulley is 8.5 feet in diameter.

3 boilers set singly furnish steam for this engine, 2 of which are used at one time: 1 56 inches by 16 feet, with 48 3.5-inch tubes; 1 52 inches by 16 feet, with 54 3-inch tubes; 1 54 inches by 16 feet, with 46 3.5-inch tubes. Each boiler has 1 steam drum, 2 have 4-inch safety valves and 1 a 5-inch safety valve. The feed water for boilers passes through a heater, through which exhaust steam passes, and is raised to a temperature of over 200°.

The record of hoisting at the Randol shaft gives the number of skip loads of rock and ore during the last 4 years as follows:

| | |
|---|---|
| 1886 | 37,371 |
| 1887 | 40,862 |
| 1888 | 41,791 |
| 1889 | 45,934 |

In 1889 the average number of skip loads hoisted each working day was 184, or 276 tons, exclusive of the number of trips made with men, timber, etc.

WASHINGTON SHAFT.—The hoisting machinery at the Washington shaft has 2 reels, 6 feet 6 inches in diameter, 24-inch face, one opposite each of the 2 hoisting compartments in the shaft. They are both placed on the same shaft, one being free to revolve and the other keyed. The latter is in permanent connection with the engine, connecting spur wheel and pinion being in a ratio of about 5.5 to 1, the teeth 2.375-inch pitch, 6-inch face. The former is made to revolve with the reel shaft by throwing into gear a clutch sliding upon 2 feathers and revolving with it. Round steel-wire rope 3.5 inches in circumference is used and wound on the reels, 1 passing over and 1 passing under. The reels are driven by a pinion on the crank shaft of a horizontal slide-valve engine, 12-inch cylinder with 24-inch stroke. A speed of 400 feet per minute in the shaft is attained. The load, when skip is at the bottom of the shaft, is 4,500 pounds. The indicator is the same as that at the Randol shaft. This machinery is situated 60 feet from the shaft and set on a foundation of timber. There are 2 boilers, each 56 inches in diameter, 16 feet long, with 48 3.5-inch tubes.

The gallows frame consists of 2 perpendicular upright beams 16 by 20 inches in section, 43 feet 4 inches high, standing on 16 by 18 inch sills 56 feet long, and braced in the line of thrust by inclined beams 16 by 18 inches, 56 feet long. The 2 uprights, 1 at each side of the shaft, stand 20 feet apart and are trussed at the height of 28 feet by a horizontal timber 18 by 20 inches, supported by short braces or struts of 9 by 20 inches. Across the tops of the uprights and connecting both is another horizontal beam 18 by 20 inches. Perpendicular posts 12 by 20 inches are framed between the 2 horizontal beams and carry the sheaves, the shafts of which are 35 feet 6 inches above the floor of the shaft house. The sheaves are 8.5 feet in diameter.

The 2 hoisting machines for prospect shafts as used at the Almaden and Saint George (now at San Francisco) have each 2 steam cylinders 6 inches in diameter, with a stroke of 12 inches. A reel, supported by brackets cast on engine frames, is fitted to each. They are 20 inches in diameter, 10.5-inch face. A spur gear is cast on the side and is driven by a pinion on crank shaft of the engine. The ratio is 4 to 1; pitch of teeth, 1.5 inches, 3.5-inch face. The load, including 500 feet of wire rope five-eighths of an inch in diameter, is 2,000 pounds, and is raised at a speed of 300 feet per minute. A foot brake is applied on the reel.

The upright boilers supplying steam to these engines are 42 inches in diameter and 8 feet high, each having 99 2-inch tubes. They stand on cast-iron base plates 10 inches high, forming the ash pit, and have brackets carrying the boiler feed pumps. Each boiler has a steam drum and a 2-inch safety valve.

The gallows frames are of the truncated pyramid style, overhead pulleys 36 inches in diameter.

### THE ENGINEERS.

The engineers at the several shafts work in 2 shifts of 12 hours each. The cages or skips are put in motion in answer to the signals given by gongs that are connected with the different stations of the shafts by wire rope made of galvanized coarse iron wire, twisted, three-eighths inch diameter, and attached at each station to an iron lever. The general signals are: 1 bell for "hoist" or "stop"; 2 bells for "lower down". Other signals are agreed upon as circumstances require. The engineers attend to the brakes. Where 2 reels are employed, hoisting with balanced cages or skips is invariably the rule, and with single reels when lowering the skip the engine is reversed and the speed of the descent is regulated partly by means of the fly-wheel brake and partly by putting the reversing link in position for hoisting, the throttle valve of course being closed.

When raising or lowering men 1 cage only is used, the other reel, if there are 2, being then held by the reel brake. The speed of the cage in the shaft is then from 300 to 400 feet per minute, and its descent is regulated in the same manner as in the single-reel hoist, by fly-wheel brake and reverse bar, the operating reel being invariably in connection with engine when men are in the shaft.

The boilers are cleaned regularly at intervals of from 2 to 4 weeks, according to the amount and kind of water used. The water is supplied from 3 sources, one of which supplies a limited amount of very pure water, that forms little or no scale in the boilers in which it is used. The water obtained from the other sources forms a very hard scale, which necessitates the use of boiler-cleaning compounds, besides a liberal use of the scaling hammer, to keep the boilers in good condition. Every boiler has a manhole in front, below the tubes, through which access is gained to the sheets immediately over the furnace, which are thus kept thoroughly clean. The vertical tubular boilers, being inaccessible on the inside, require to have the tubes removed about every 2 years, when they are thoroughly cleaned and the tubes replaced.

### HORSE WHIMS AND WINDLASSES.

For prospect shafts there are also, for hoisting, 2 horse whims. The reel is 7 feet diameter, 10-inch face, and revolves on a 3-inch shaft with vertical axis. The sweep rod can be thrown in or out of gear at will, as the bucket is required to ascend or descend. An iron strap brake is applied to regulate the descent of the bucket, the sweep rod being then out of gear. A half-inch steel wire rope is used. The load is about 300 pounds, and moves through the shaft at about 70 feet per minute.

The windlasses used for prospect work have a wooden reel 6 inches in diameter and 4 feet long, with wrought-iron crank handles inserted in the ends, which are strengthened by iron rings being driven on them, the axles being formed by a part of the crank handles projecting from the ends of the reel in a direction parallel with its axis. 2 upright pieces, generally of 1.5 by 12 inch pine board set in a mortise cut in a 6 by 6 inch cross-timber, support the reel, and are connected by a plank, the ends of which rest upon and are spiked to the upright pieces. On the top of this board is a wooden bar, sliding in guides, which is drawn out far enough to catch the handles and prevent the reel from revolving when it is required to hold the bucket and keep it in position desired. When lowering the bucket a brake is applied on the reel, and consists of a rope, one end of which is made fast to the crosspiece and a turn taken around the reel in the direction of its motion when lowering. The loose end is then drawn tight, as may be required to command the descent of the bucket. 2 buckets are sometimes used, the rope having a number of turns on the reel, with 2 free ends. To these ends the buckets are attached and assist in balancing each other. As the depth of the shaft increases a turn is taken off the reel, adding to the length of the free ends. The load is about 100 pounds. 3-inch hemp rope is used. 100 feet can be sunk in this way.

### AIR COMPRESSORS.

To supply compressed air for operating machine drills, pumps, and other machinery in the mine there are 2 air compressors erected in the Santa Isabel shaft house: 1 Burleigh air compressor, with steam cylinder of 18 inches diameter and 24-inch stroke, the air cylinder of 24 inches diameter and 20-inch stroke, discharging into receiver 54 inches in diameter, 12 feet 6 inches high; 1 Clayton air compressor, with 2 steam cylinders, each 14 inches in diameter, and 2 air cylinders of 12 inches diameter, all of 9 inches stroke. The air cylinders are double acting. The receiver is 36 inches in diameter and 9 feet long. Another Burleigh air compressor, with steam cylinder of 15 inches diameter and 18 inches stroke, and air cylinder of 15 inches diameter and 15 inches stroke, discharging into an air receiver 48 inches in diameter, 10 feet 6 inches high, is on hand, having been in use at the Washington and Buena Vista shafts.

### MACHINE DRILLS.

The rock drills, 11 in number, are as follows: 2 3.5-inch Ingersoll Eclipse drills, 1 3.5-inch Ingersoll tappet drill, 4 3-inch Ingersoll Eclipse drills, 1 3-inch Ingersoll tappet drill, 2 3-inch National drills, and 1 2.5-inch Ingersoll tappet drill.

### VENTILATION.

For ventilation there is 1 Baker blower of a capacity of 1,500 cubic feet per minute, and 1 Baker of a capacity of 1,000 cubic feet; 1 Root blower, capacity 800 cubic feet per minute, and 1 48-inch Blackmann exhaust ventilator.

### SHAFT HOUSES.

**Buena Vista shaft.**—The shaft house at Buena Vista contains hoisting-engine room, 45 feet wide and 100 feet long; pump-engine room, 45 by 45 feet; boiler room, 45 by 55 feet, the whole forming a rectangular frame building 90 feet wide and 100 feet in length. Fire protection is afforded by 4 hydrants (2-inch), fed by a supply tank containing 15,000 gallons. The pressure of water is 70 pounds per square inch. Adjoining the boiler room there is an excavation in which 700 tons of coal can be stored. Situated near the shaft house is the blacksmith shop, 46 by 26 feet, a part of which, 18 by 12 feet, is inclosed and used as a drying and changing room for the miners.

**Santa Isabel shaft.**—The Santa Isabel engine house is 90 by 40 feet. Connecting with it at right angles is the boiler room, 60 by 40 feet. Adjoining the main building is the miners' changing room, 21 by 12 feet in extent. The blacksmith shop, about 100 feet from shaft house, is 40 by 20 feet in dimensions. 4 2-inch hydrants are placed around the building, having a water pressure of 50 pounds per square inch. Supply tank contains 15,000 gallons. The shed provided for coal storage will hold 400 tons.

**Randol shaft.**—The works at the Randol shaft are contained in an irregular building, whose greatest length is 80 feet and greatest width 50 feet, the boiler room being 40 by 32 feet. The changing and drying room for the use of the miners, 19 by 18 feet, is provided with 2 steam heaters. Placed adjacent to the shaft house are the carpenter, blacksmith, and machine shops. The carpenter shop is 24 by 40 feet in size. The blacksmith shop is 25 by 50 feet, and has 4 forges. Blast is supplied by a No. 3 Anderton blower. All of the forges are worked by day, and 1 by night. The drills dressed average about 1,000 every day at this shop. The kind of steel used for drills is 1-inch octagon black diamond. The machine shop adjoins the blacksmith shop, and is 16 by 35 feet in size. It contains 1 Putnam lathe, 12-inch centers; 1 power drilling machine, 1 Wiley & Russell bolt-cutting machine, 1 milling machine, and 1 hand-power drilling machine. These machine tools are driven by a 6 by 16 inch steam engine, and are used in making and repairing cages, skips, cars, tanks, etc., and in repairing the machinery at the different shafts. 2 2-inch hydrants, with 35 pounds water pressure, supply protection against fire. 600 tons of coal can be stored at this shaft.

**Washington shaft.**—The engine house at the Washington shaft is 99 by 32 feet, the adjoining boiler room being 40 by 32 feet. 300 tons of coal can be stored at this shaft. The blacksmith shop and carpenter shop are near the main building, the former being 25 by 40 feet in extent, having 2 forges. The carpenter shop is 32 by 60 feet. 1 2-inch hydrant is provided for fire protection. To the hydrant is attached 50 feet of 2-inch hose, and all other hydrants at the shaft houses are similarly provided. The changing room is 12 by 20 feet.

**The Almaden** engine house is 34 by 78 feet, the boiler room 24 by 36 feet, which also contains the blacksmith shop.

**The San Francisco** shaft house is 20 by 54 feet; height of gallows frame is 16 feet, 14 feet spread at the bottom and 8.5 feet at the top.

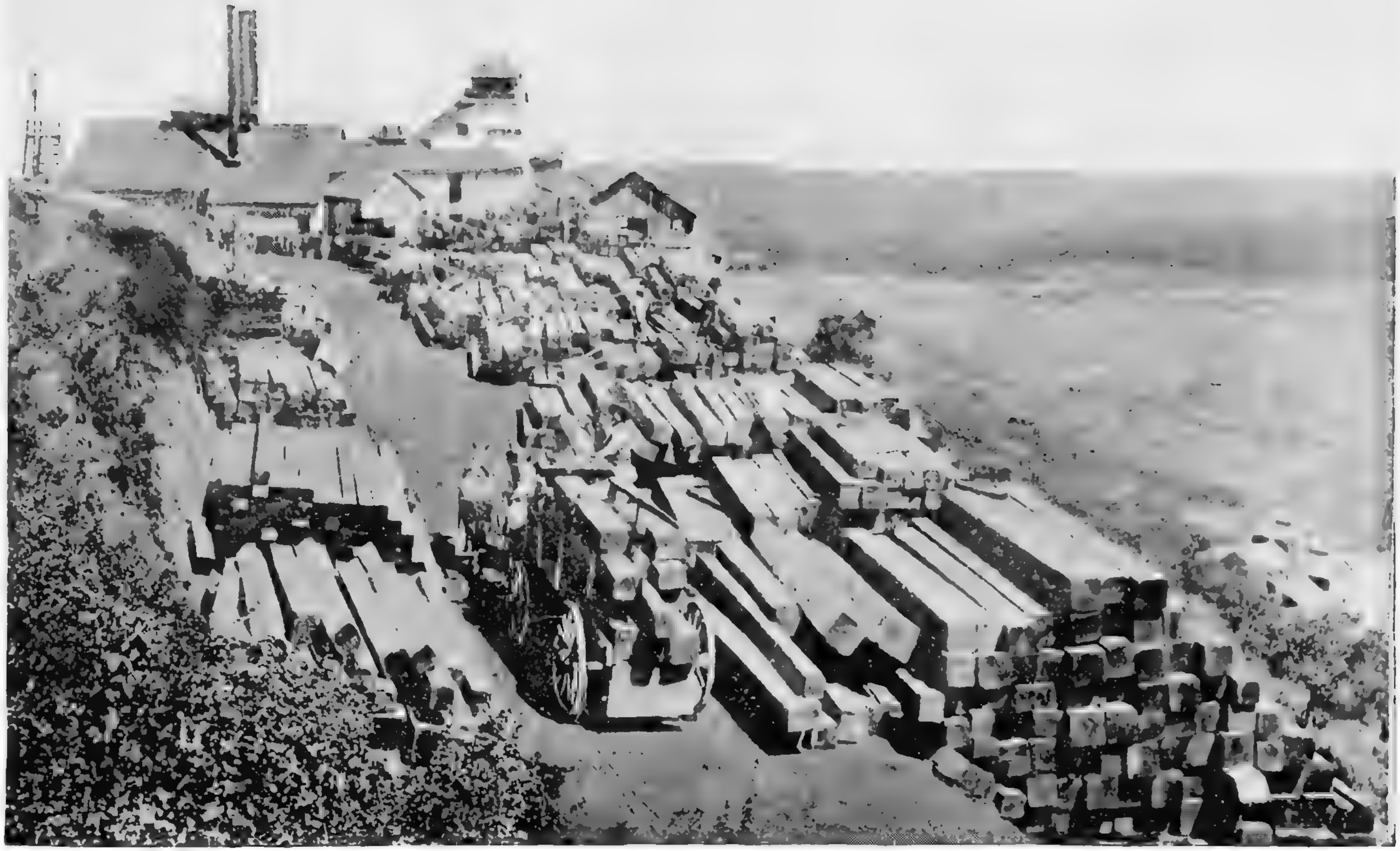
### LIST OF ENGINES, ETC., AT NEW ALMADEN.

#### HOISTING ENGINES.

| LOCATION. | GEARED. | | | | DIRECT ACTING—2 CYLINDERS. | | |
|---|---|---|---|---|---|---|---|
| | Single cylinder. | Double cylinder. | Diameter of cylinder. (Inches.) | Stroke. (Inches.) | Number of engines. | Diameter of cylinder. (Inches.) | Stroke. (Inches.) |
| Randol shaft | 1 | | 16.5 | 30 | | | |
| Santa Isabel shaft | 1 | | 16.0 | 36 | | | |
| Buena Vista shaft | | 1 | 12.0 | 24 | 1 | 16 | 60 |
| Washington shaft | 1 | | 12.0 | 24 | | | |
| Saint George shaft | | 1 | 6.0 | 12 | | | |
| Almaden shaft | | 1 | 6.0 | 12 | | | |

#### STEAM PUMPS.

| LOCATION. | DOW. | | KNOWLES. | | WORTHINGTON. | | CAMERON. | | STODDARD. |
|---|---|---|---|---|---|---|---|---|---|
| | No. 4. | No. 6. | No. 5. | No. 0. | No. 1. | No. 2. | No. 0. | No. 5. | No. 5. |
| Randol shaft | 1 | | | | | 1 | | | |
| Santa Isabel shaft | | | | 1 | | | | | 1 |
| Buena Vista shaft | | | | 2 | | | | | |
| Washington shaft | | | | | 1 | | | 1 | |
| Saint George shaft | | | | | | | 1 | | |
| Hacienda | | | | 1 | | | 1 | | |
| In storeroom | 1 | 2 | | | | | | 1 | |



RANDOL SHAFT, NEW ALMADEN, CALIFORNIA, IN 1889.

LIST OF ENGINES, ETC., AT NEW ALMADEN—Continued.

ENGINES FOR GENERAL SERVICE.

| LOCATION. | HORIZONTAL. | | | VERTICAL. | | |
|---|---|---|---|---|---|---|
| | Number of engines. | Diameter of cylinder. (Inches.) | Stroke. (Inches.) | Number of engines. | Diameter of cylinder. (Inches.) | Stroke. (Inches.) |
| Randol shaft | 1 | 6 | 16 | | | |
| Buena Vista shaft | | | | 1 | 6 | 8 |
| Almaden shaft | | | | 1 | 6 | 7 |
| Hacienda | 1 | 8 | 16 | 2 | 6 | 7 |
| In storeroom | 1 | 6 | 12 | 1 | 6 | 7 |

AIR COMPRESSORS.

| LOCATION. | BURLEIGH. | | CLAYTON DUPLEX. |
|---|---|---|---|
| | No. 3. | No. 7. | No. 3. |
| Santa Isabel shaft | | 1 | 1 |
| Washington shaft | 1 | | |

PUMPING ENGINES.

| LOCATION. | GEARED. | | | COMPOUND CONDENSING, DIRECT ACTING. | | | | |
|---|---|---|---|---|---|---|---|---|
| | Number of engines. | Diameter of cylinder. (Inches.) | Stroke. (Inches.) | Number of engines. | High-pressure cylinder. | | Low-pressure cylinder. | |
| | | | | | Diameter (Inches.) | Stroke. (Inches.) | Diameter (Inches.) | Stroke. (Inches.) |
| Santa Isabel shaft | | | | 1 | 19 | 60 | 26<br>42 | 60 |
| Buena Vista shaft | | | | 1 | 21 | 96 | 47 | 70 |
| Washington shaft | 1 | 10 | 20 | | | | | |

## MACHINERY AT HACIENDA.

The machine shop at the hacienda contains 1 screw-cutting lathe with 9.5-inch centers, 1 flask-tapping and threading machine, 1 Wiley & Russell bolt cutter, and 1 power drilling machine.

The engine house contains 2 horizontal tubular boilers: 1 of 50 inches diameter, 15 feet long, with 40 3.5-inch tubes, and 1 of 30 inches diameter, 11.5 feet long, with 19 3-inch tubes; 1 Knowles steam pump, No. 7; and 1 horizontal steam engine, with 1 cylinder of 8 inches diameter and 16-inch stroke, driving soot machine, also set up in the engine house.

## DESCRIPTION OF TOOLS.

The hammer is a piece of steel, weighing from 7 to 8 pounds. It has 2 striking faces or polls, the eye in the center being 1.25 inches in diameter, into which the helve or handle, about 2.5 feet long, made of ash or hickory, is fastened.

The drills are octagonal bars of cast steel, about 1 inch thick, cut in lengths of 1.5 to 4 feet. One end is flattened out wedge-shaped and drawn to 1.125 or 1.25 inches in width.

The scraper is a three-eighths-inch bar of round iron, 3.5 to 4 feet long, on one end of which a hemispherical spoon is hammered out at right angles to the axis of the bar, while the other end has a half-cylindrical spoon about 6 inches long, which is used in charging drill holes with black powder when their direction is horizontal or slightly upcast.

The swab stick is a piece of round wood three-fourths of an inch in diameter and 3 or 4 feet long. One end is bruised into the shape of a brush, to which the sludge from the drilling adheres and is drawn from the drill hole.

The "gad" is a piece of drill steel 6 inches long made into the form of a wedge. It is used to wedge off fragments of rock, or for breaking ground which does not require blasting.

The "moyle" is a bar of drill steel from 1 to 2 feet long with 4-sided point. It is used like the gad, and is especially employed in cutting the so-called "hitches" for timbers.

The pick is made of a square bar of iron 1.5 inches thick and slightly curved in the plane of the handle. It has a 4-sided pyramidal steel point at the curved end, and a poll 3 inches long at the other end. It has an eye like the hammer 3 inches from the face of the poll, into which the ash or hickory handle, about 2.5 feet long, is inserted and secured.

The shovel is the ordinary long or short handled square or round-pointed shovel. They are bought with the helves fitted to them.

These constitute the regular kit of tools with which the miners are provided by the mining company. Broken pick handles or hammer handles are replaced by the miner who uses the tool.

The wheelbarrow is used in some of the prospect drifts, where a regular track for tramming has not been laid. The wheelbarrow used in mining is made of wood, and is of the old Cornish type called the "Jack" wheelbarrow.

The timbermen use axes, crosscut saws, handsaws, augers, chisels, sledges, block and tackle, and ropes, furnished them when needed.

### EXPLOSIVES.

Black and dynamite powders are stored in the company's powder magazine, a solid brick building, well protected and standing isolated at a safe distance from the Randol shaft. The percussion caps and fuse are kept apart in the company's storehouse. The black powder used is the size F from the Santa Cruz powder mills, and the other powder is dynamite No. 2. The explosives used in the footage labores are under the charge of the blaster, who receives at one time from 25 to 30 kegs (of 25 pounds each) of black powder and about 100 pounds of dynamite powder from the magazine and stores them in an underground magazine built in an abandoned labor or situated at a safe distance from the workings. About 100 to 200 feet of fuse only are taken into the mine at one time, so as to prevent its getting damp from exposure to the atmosphere underground. The blaster keeps in his magazine, which is under lock and key, also all the tools used by the timbermen working in the labor. The contractors working under the tribute system for ore, or having contracts for drifting or sinking or other prospect work, store their explosives in a safe place at a distance from their work. The dynamite powder for ordinary drill holes is bought in sticks about 8 inches long and 1 inch in diameter. For machine drills the sticks are 8 inches long and 1.5 inches in diameter.

To charge a hole with dynamite powder a fuse of the required length is first prepared, one end of which is shaped to go into the cavity of the cap. The cartridge is then put into the drill hole and pressed tightly in place with the swab stick. It is often found convenient to break the stick of powder into halves before placing it in the hole, for the reason that it will more readily expand when pressed down by the swab stick and more completely fill the drill hole without leaving voids. Sometimes in very hard ground a half or a whole stick more of powder is placed on top of the first one. The fuse with the cap then being placed down on the cartridge, the hole is filled with fine dirt loosely thrown in and slightly tamped, while a wet hole is simply filled with water in place of tamping.

The charging with black powder is done as follows: If the hole is downcast, half of the charge of powder, from 4 to 7 inches of the drill hole, is poured in, the fuse with the cap is inserted, and the other half of the powder charge is poured on top. The hole is then tamped, which consists in packing from 12 to 18 inches of fine dirt on top of the powder by the use of the tamping bar or swab stick. After the hole has been properly tamped a small piece of candle (or snuff) is placed under the outhanging end of the fuse, to be lighted when all holes have been charged and are to be fired. An upcast hole is charged with a cartridge made of powder. These are cylinders made of soaped paper, 1 inch in diameter and from 12 to 18 inches long, filled with powder. The fuse is inserted in the middle, as in charging with loose powder. The object of the paper cylinder is simply to retain the powder, and the paper is soaped so as to keep the powder together. These cartridges are tamped and fired in the same way as with loose powder.

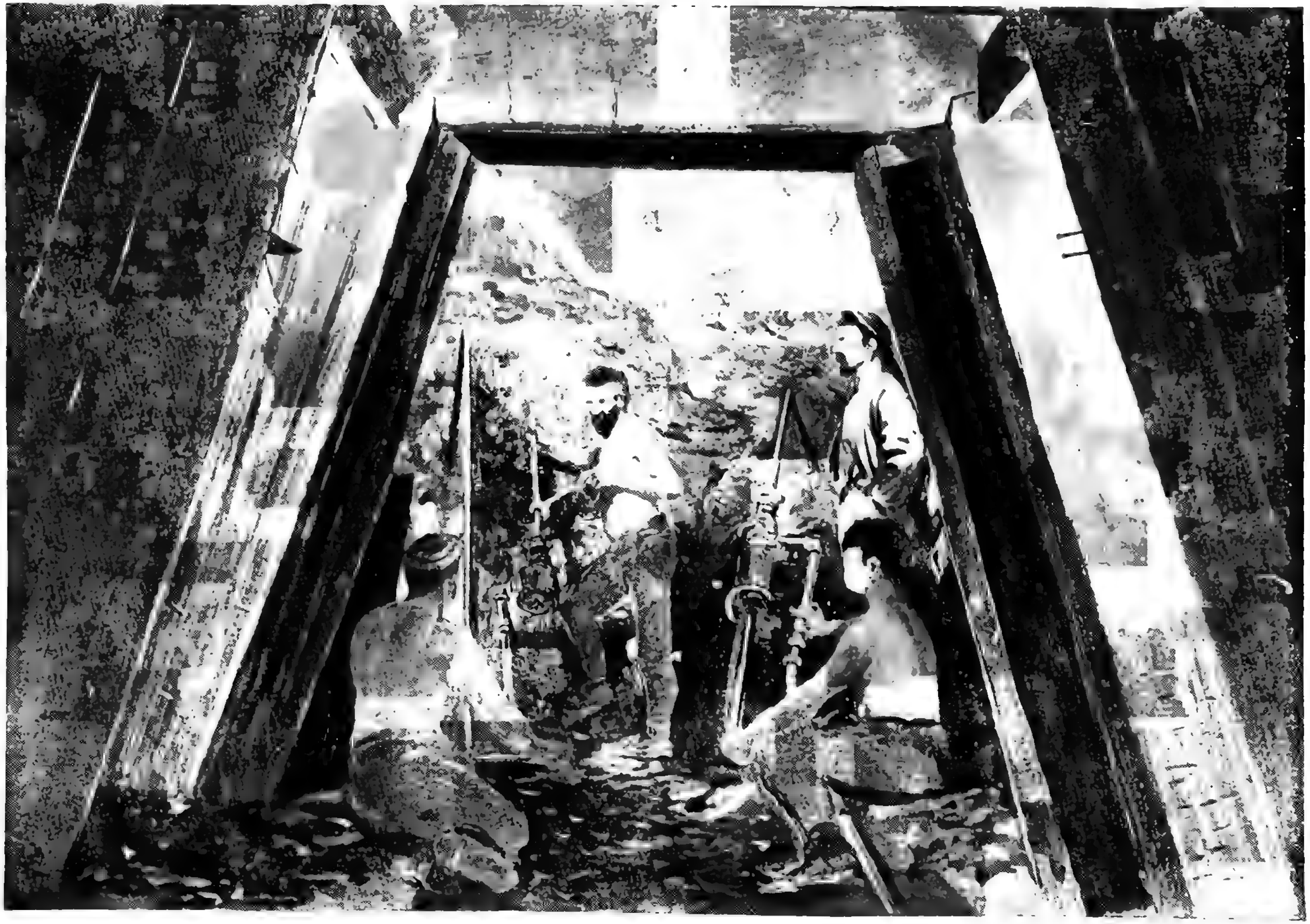
In drilling, the place selected for the hole is started, if possible, with a pick. A man then takes a short drill, and, holding it steadily in both hands in the direction the drill hole is wanted, lets his partner strike the other end in successive strokes with the hammer. After each blow he raises the drill slightly and gives it about one-tenth of a turn. In this way the rock is chipped and a cylindrical hole is formed. Water is poured in the hole if possible, as it is found to expedite the drilling, converting the dust into a wet sludge, in which state it is easily removed from the hole. A rag or washer is put around the drill to prevent the splashing of the water. As the depth of the hole increases a longer drill is used, and by continuing in this way a hole from 4 to 6 feet deep may be drilled. The ordinary drill holes are usually from 1 to 4 feet deep, according to circumstances.

### METHOD OF WORK.

Men employed in prospect work labor in gangs as follows: For shaft sinking, usually 9 men, in 3 shifts of 8 hours each, one shift going to work at 7 o'clock in the morning, the next at 3 o'clock in the afternoon, and the third shift at 11 o'clock at night. No time is allowed for regular lunch. For sinking winzes, 6 men, in 2 shifts of 10 hours each, are employed; for raising a winze, 4 men, in 2 shifts of 10 hours each; for drifting, 4 men, in 2 shifts of 10 hours each. These rules are sometimes altered to suit circumstances.

Drifting with machine drills is done by 9 men in 3 shifts of 8 hours each. Most of the drifting and sinking is done by hand drills. Machine drills are only employed in straight tunnels or crosscuts and in the larger shafts when a rapid progress of the work is desirable.

In prospect drifts miners follow the contact of the vein or the footwall with the hanging wall (alta). To do this requires some experience, as the variable nature of the rock makes this distinction at times very difficult. For



TUNNELING AT THE NEW ALMADEN QUICKSILVER MINE.

this purpose the shift bosses and the mining captain visit daily the different parts of the mine where explorations are going on to make sure that no errors are made by the contractors in following the vein.

It is the rule of the company that in drifting, sinking, or raising the contractor has to follow the line of contact between the alta and vein or footwall, one-half of the drift being in either ground, and that should the contact be lost and the breast of the prospect show a decided change to either, running all in alta or all in vein, the contract is considered finished, and new arrangements have to be made as to price before work is continued as directed under the new circumstances.

In crosscuts and inclines or upraises where a certain direction is to be maintained in order to reach a certain point, lines are hung by the surveyor from the roof of the drift to indicate the required course.

The timbering of drifts, shafts, winzes, or crosscuts is done by the contractors in pursuance of their work, and is included in the contract price. The detail part of the work is left entirely to the company of miners (contractors), under the supervision of the shift bosses and the mining captain, and the timber is sent into the mine once a week for this purpose, usually Saturdays. Miners working on footage are paid for the loss of time in transporting the timbers to the labores and in assisting the timbermen, while men working on tribute or by contract do this work without compensation, as it forms a part of their contract. For the underground transportation small 4-wheeled trucks are used. The timbers are stored underground partly in the upper plats of the stations, partly in side drifts that are unused, or at other places on the line and out of the way of the tramming cars.

The system used in the prosecution of the prospect work is called the "yardage system", because the work is paid for by the linear yard in depth or distance excavated. The yardage work is almost entirely done by contract. The several drifts, shafts, winzes, or crosscuts selected by the management of the mine as the future month's work are publicly posted at the company's office on the hill 1 or 2 days previous to the acceptance of the bids, in order to give the miners sufficient time to view the ground and satisfy themselves as to the difficulties and the hazard of the undertaking. The bids are received on raya day (pay day), which falls usually on the last Saturday of every month, and when all bids are received they are compared and, the lowest or most advantageous ones being selected, the awards are made public on the same day. Bids for footage work, tramming, and skip filling are received at the same time.

### TIMBERS.

All the timbers used underground are of squared hewn redwood. The thickness varies from 8 to 16 inches, the length from 8 feet to 16 and 20 feet. The lagging is 3, 4, or 6 feet long, and has a thickness of 3 by 6 inches in cross section. Ties for car tracks are 4 by 6 inches in cross section and 4 feet long. Timbers are stored on the surface near each shaft, a year's supply being always kept on hand. Here the timbers are framed for the required work, including timbers for shafts, winzes, and drifts, which are of known sizes, while the timbers for use in the labores are sent into the mine in whole lengths and cut to proper shape underground. The required sizes and numbers are selected and marked with their destination, the shaftman keeping an account of every size and length of timber sent into the mine.

Every Saturday, as already mentioned, is set apart for sending down into the mine timbers that will be required during the coming week. At the Randol and the Santa Isabel shafts cages especially built for the transportation of timbers are employed. The timbers are made to stand up on the platform of the cage, while the upper ends are securely lashed to its frame. The timbers are lifted into this cage by a hand winch, using a 1-inch manilla rope, to which 2 chains are fastened with dogs at their ends, that are driven into the timber. They are brought to the shaft on small trucks, and when at the proper station in the shaft are received there by the men, who unload them from the cage by the dexterous use of rollers, aided by the engineer on the surface by slowly hoisting at the given signal. A regular force of timbermen, from 15 to 20, attend to the general timbering in the mine, as repairing and replacing old or wornout or broken timbers in drifts and labores or winzes, and framing timbers for these purposes on the surface. These timbermen are paid by the month, and have their light furnished.

The timbering of the footage labores is done under the supervision of the blaster (who is in charge of the labor) by the timbermen, assisted by the miners working on footage contract if necessary, for which work they receive day's pay.

The yardage work is measured at the end of the contract, which usually extends to the end of every month, by the mining captain, aided by the surveyor, and in presence of the mining superintendent. The footage work is measured daily before blasting the holes by the blaster or foreman of each labor.

Contracts with tributers are renewed every month by the mining captain and superintendent, who then inspect every tributer's pitch or labor, and agree with the company of tributers on the price to be paid per ton of cleaned ore.

The laborers in the mine are paid by the day and provide their own light. Their work consists in shoveling ore in the footage labores down to the platform, where it is handy for the cars; assisting the timbermen, shaftmen, and pumpmen; filling skips in shafts, and tramming cars where this work is not given out by contract; dumping the cars at the planilla during nighttime, and other services. About 20 men are employed in these occupations, in 2 shifts of 10 men each.

One man, an experienced miner, is employed at each shaft to attend to all work that pertains to it, looking after the pumps, skip roads, station plats, ladder ways, shaft timbers, and general repairs. He is assisted by laborers or timbermen as required. The shaftmen are paid by the month and are furnished with light.

The mining captain is the superintendent of all underground work, which he directs with the aid of the shift bosses. All matters relating to mining are reported to him.

There are 2 shift bosses, alternating, or day and night shifts. They inspect during their shift all work done in the mine by prospectors or tributers, also the laborers, timbermen, trammers, etc., marking down labor shifts and footage work, and reporting the same at the office. They see that the proper force of men is at work everywhere, and in cases of absence that substitutes are provided to insure the regular working at all places.

### SURFACE WORK.

The surface foreman supervises all surface work not directly connected with mining. He makes the requisitions for all necessary supplies and materials, which he keeps in store, and accounts for them as they have been received and distributed. All improvements on the surface, dwellings, boarding houses, storehouses, offices, shaft houses, roads, water works, telephone lines, etc., are under his direct supervision, so also the working of the old surface ore dumps, the planilla work, stables, and transportation. He collects the rents for dwellings and ground lease, is the manager of the Helping Hand hall, and looks after the sanitary and general police regulations.

The surveyor attends to all surveying on the surface and in the mine and the mapping thereof. He makes monthly a report on the progress of the prospect work, the condition of the labores, the quantities of ore and waste rock hoisted at the different shafts, and ores sent to the hacienda reduction works.

The clerk in the hill office keeps the monthly and daily account of all labor performed and ore produced, and the pay rolls.

The chief engineer has charge of all machinery, boilers, and the blacksmith and machine shops on the hill and at the hacienda. His monthly report contains: skip loads of ore and waste rock hoisted at each shaft; trips with men and timbers; average steam pressure in pounds; average vacuum in inches; temperatures of feed water, of hot-water well, and injection water; revolutions of pumping engines; number of gallons of water raised; amount of coal used at boilers, in blacksmith shop, and for steam pumps; amount of coal and firewood on hand; quantities of different lubricants used, and other notations of interest.

Transportation is done by contract. The contractor keeps his horses and wagons at the hacienda. He provides teams at fixed contract prices, and hauls the ore from the planillas or the old surface dumps to the ore chutes at a certain price per ton. The hauling of timber, coal, wood, and other supplies is also by contract. Between 70 and 80 draft horses and mules are employed in this work.

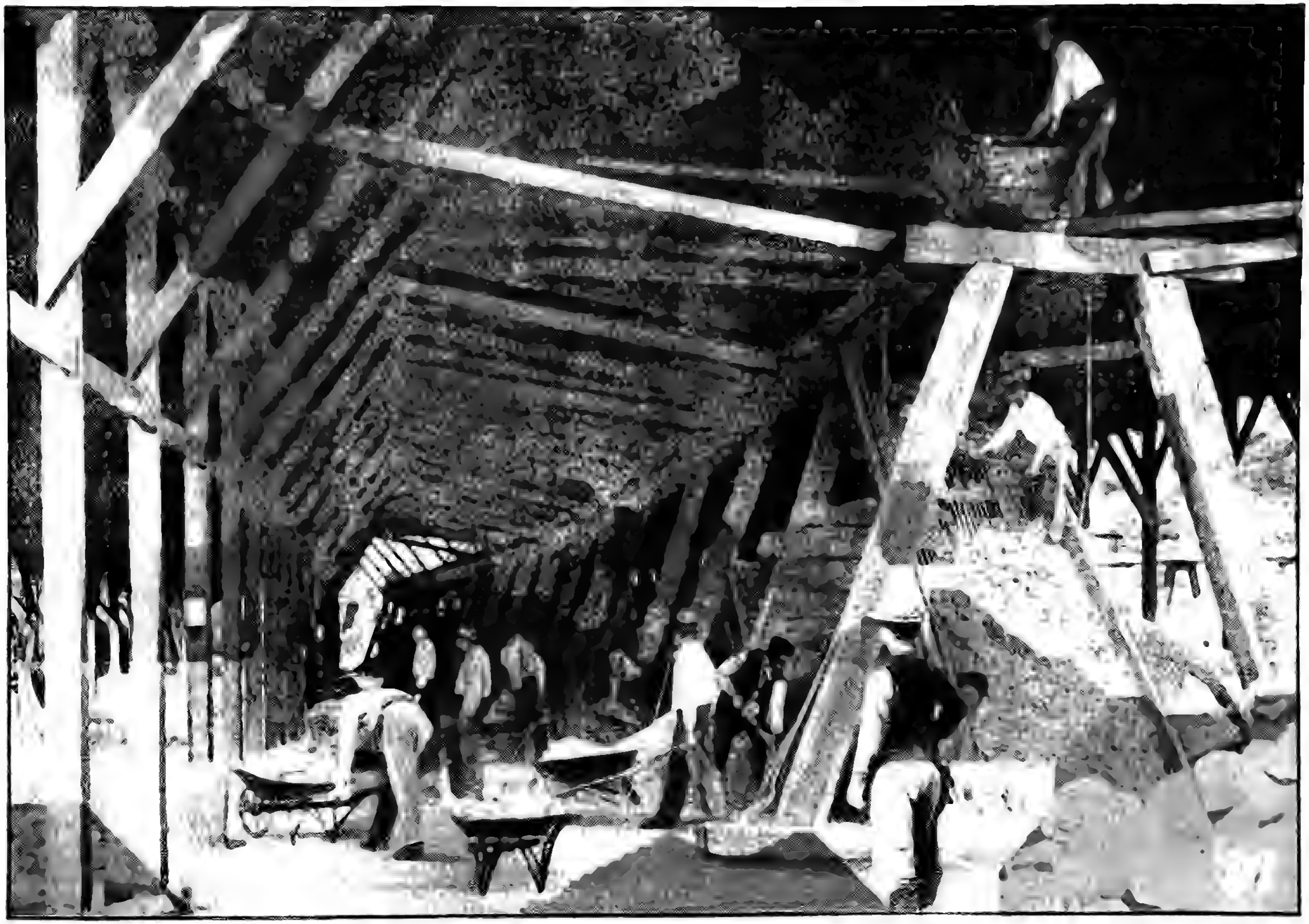
### ORE DRESSING AND TRANSPORTATION.

The vein matter, just as it is broken in the labores or stopes of the mine, is run out in cars on an elevated tramway above the planilla or dressing floor belonging to each principal shaft. The most important is the Randol planilla, which is situated at the mouth of the Randol tunnel. All of the rock hoisted at the Randol shaft is trammed out through this tunnel. 6 cars, holding 1.5 tons each, are used to transport the rock. While 2 full cars are being drawn out 2 others are being filled and the other 2 are being dumped. Switches and double tracks at the shaft and mouth of the tunnel enable the change of trains to be made.

The loaded cars are received at the mouth of the tunnel by a man called the "dumper", who runs them into the planilla shed or to the "tepetate" dump, accordingly as they contain "metal" (pay ore) or barren rock from drifts and crosscuts.

The Randol planilla floor is 14.5 feet below the track. At intervals of 32 feet iron bar screens are placed which extend from the track to the floor at an angle of 45°. The screen bars are made of wrought iron and are placed from 1 inch to 1.25 inches apart. The bars are slightly chamfered in cross section to prevent choking. To prevent spreading they are stayed with cast-iron crossbars at intervals of 4 feet, and to take the sudden jar of large rocks dumped from the cars above short pieces of heavy T rails are placed longitudinally in the upper end of the screen. The sides are constructed of heavy scantlings. The outside width of the 9 screens is 5 feet. Upon these screens the metal is dumped, and what passes through is known as "tierras". The coarse fragments which fail to pass the screens are carefully picked over. On account of the tribute system it is necessary to keep the ore produced by each body of miners in a pile by itself, and as the ore produced by each company of footage men is also kept separate, the production of ore ("granza") from each level and ore stope is accurately known. The tierras are allowed to mix indiscriminately. Metal is cleaned only during the daytime, the work being done by men and boys. Rock hoisted during the night shift is dumped on the screens and cleaned the next day, the capacity of the screens being sufficient to allow this without inconvenience.

It has been already mentioned that the breaking and mining of the ores is done by two systems, one called the footage system, the other the tribute system. The ore broken by the footage system on the different levels of the



CLEANING QUICKSILVER ORE.

mine is also kept separated on the planilla in order to credit each level with the amount of ore produced. 2 or more levels are usually so represented on the planilla. For all these reasons the ores coming from different sources have to be dumped over separate screens. In cleaning, the ore which does not pass the screens is piled separately for each company of tributers and for each level, so that it may be weighed separately and credit be given accordingly. There are at times as many as 15 companies of tributers so represented on the planilla, besides the footage labores from 2 or 3 different levels, all of which have their ore piled in separate heaps.

The sorting is done very rapidly, and the rich pieces of ore picked out. All pieces of rock which do not contain any signs of metal are thrown into a car and brought to the waste dump. Large rocks containing some ore and much waste rock are piled on one side to be cleaned by spalling or breaking the rocks with sledge hammers and separating the waste rock. What is left over is taken to the pile of ore where it belongs. The cleaning of the ore in this way is speedily done.

Transportation of ore.—From the planilla floor the ore and tierras are loaded into ore wagons and weighed on platform scales. These wagons, drawn by 4 horses, hold about 3 tons of medium-grade ore, and transport the ore and tierras a distance of about 1.33 miles along a nearly level but very winding road to a series of bins, from which the ore and tierras are dumped into cars. A railroad track extends from here a distance of 1,600 feet to the head of a self-acting incline. The cars in trains are drawn over this track by a mule. The cars hold about 2 tons each, and have a gauge of 3 feet. They are lowered down the incline, the speed of descent being regulated by a brake operated by a long lever. A loaded car brings up at the same time an empty one. 3 rails form the 2 tracks of the incline, except midway, where, to avoid meeting, the cars switch apart on 2 parallel tracks. The connecting cable, a wire rope 1 inch in diameter, passes 3.5 times around an iron drum 6 feet 6 inches in diameter placed at the head of the incline. This drum is controlled by a hand brake acting upon a wheel 7 feet in diameter, and the brake levers are coupled so as to give a leverage of 57 to 1. The brake band is 6 inches wide, and consists of iron lined with hard wood. The incline trucks are surmounted by a horizontal platform upon which the ore cars rest, this platform when at either end of the incline being level with the railroad tracks. The incline is about 830 feet in length, and has a slope of about 28°. The cable is supported by wooden rollers placed between the rails at intervals of 24 feet. From the foot of the incline the cars, in trains of 5, are drawn by another mule on a track to the ore bins and screens near the furnaces. The cars are arranged to dump sidewise, being tilted up by means of levers, while at the same time the side of the car is swung open.

As already mentioned, these cars hold about 2 tons of ore or tierras, but the exact weight is never taken, as the amount shipped each day is reported from the planilla.

Two classes of ore, sorted according to size, thus reach the reduction works at the hacienda, viz, granza (coarse) and tierras (fine). Formerly, when the old dumps were being worked over, the coarse ore so obtained was called "terrero", to distinguish it from the granza of the mine. This class is no longer produced. Old dumps are still being worked for tierras, but all coarse fragments are separated by means of ore forks and rejected if waste rock, or broken small if they contain cinnabar. An intermediate size of ore called granzita is obtained, at the hacienda principally, by passing the mine tierras over screens with 1.25-inch meshes. The ore product is classified as follows:

SIZES OF ORE PRODUCT.

| | |
|---|---|
| At the mine | Ore or granza, coarse, rich.<br>Tierras, fine, poor. |
| At the works | Granza, 8 to 3.5 inches, rich.<br>Granzita, 3.5 to 1.25 inches, poor.<br>Tierras, 1.25 inches to dust, poor. |

There are 4 screens into which the tierras from the mine are dumped. No. 1 screen consists of 36 cast-iron meshed plates 1 inch thick and 2 by 2.5 feet square. The screen is 4 plates (8 feet) wide and 9 plates (22.5 feet) long, and has an inclination of 45°. The meshes are 1.5 inches square on the upper side, and larger underneath to prevent clogging, the diagonals of the meshes being parallel to the sides of the plate. At the bottom of the screen there are 2 draw chutes, 1 for tierras and 1 for granzita. No. 3 screen is 4 plates (8 feet) wide and 5 plates (12.5 feet) long. The meshes are like those in No. 1, but the plates are placed at an angle of about 40°. No. 6 screen is 4 plates (8 feet) wide and 6 plates (15 feet) long, with an inclination of about 35°. The plates are similar to those in Nos. 1 and 3, except that the sides instead of the diagonals of the meshes are parallel to the sides of the plates—an arrangement not considered so good as that in Nos. 1, 7, and 3. 4 chutes, 2 for tierras and 2 for granzita, are provided. The ore, although screened at the mine, is again screened at the reduction works to free it from the small quantity of fine material produced by the cleansing and transportation.

4 ore bins are provided, having a capacity of 40, 80, 80, and 700 to 800 tons, respectively, all under cover. The 40-ton bin is provided with a screen consisting of longitudinal 1.5-inch wrought-iron bars 2 inches apart and 12 feet long, placed at an angle of about 40°. The ore is loaded into cars from 2 chutes. 2 chutes are also provided for the screened granzita and tierras. The 2 80-ton bins are simply inclosed incline planes, each of which has 2 chutes for discharging the ore into the cars. The 700 to 800 ton bin is a large inclosure for storing ore. Cars

for granzita and tierras are provided with screens on top of the car box. For tierras the meshes are 1.25 inches square and for granzita 2.25 by 3.5 inches.

Granzita taken from the chutes is usually charged directly into the furnaces. The surplus is stored in a shed 19 feet wide, 100 long, and 20 feet high, adjoining furnaces Nos. 1 and 2.

Tierras are rarely sufficiently dry to charge directly into the furnaces. Those containing clay are particularly objectionable, and must be thoroughly dried before being roasted. The driest tierras are dumped into No. 3 screen and brought to the tierra dump under the roof between furnaces Nos. 3 and 8, a place 60 feet square, surrounded on 3 sides by bulkheads, and are there dumped in large piles. Wet tierras are dumped into screens Nos. 1 and 6, and from there are brought into the yard during favorable weather to be spread out and exposed to the drying influences of the sun and wind.

Very wet tierras are stored aside in a shed containing room for about 3,000 tons. The tops of the condensers of Nos. 3, 6, and 8 furnaces are utilized for drying tierras spread out in thin layers over the heated surfaces. A system of tracks and floors renders this distribution very easy. The driers in connection with the first condensers of No. 6 and No. 3 furnaces are fully described in Professor S. B. Christy's article on "Quicksilver condensation at New Almaden", volume XIV of Transactions of the American Institute of Mining Engineers, 1885.

In order to raise the tierras and granzita to the level of the furnaces after the screening and drying operations are ended, 2 water-balance elevators, 1 on each side of the creek, are provided. Each elevator consists of 2 iron tanks of equal size moving in guides and connected by means of a wire rope, which passes over a sheave, and moving in 2 compartments, each formed of 4 8-inch square pieces, which serve to guide the tanks. The tanks are 4 feet by 5 feet by 2 feet deep, having platforms and tracks on top for the cars. Pits are sunk in the floor of each compartment in order to bring the platform of the tanks level with the tracks in the yard. The connecting rope is three-fourths inch in diameter, and passes 2.5 times around the sheave, 6 feet in diameter. A band brake acting on a drum (5 feet 3 inches in diameter) on the sheave controls the speed. The water for overbalancing the loaded car is introduced at the top of the elevator by means of a swinging pipe and is discharged at the bottom through an automatic valve.

The distribution of the tierras and granzita from the chutes to the various required points in the furnace yard is effected by means of wooden cars. The granzita and tierras cars hold 1,000 pounds. The boxes are 13 inches by 30 inches by 49 inches inside. The charging cars for coarse ore or granza are 1 foot 3 inches by 2 feet 9 inches by 6 feet 4 inches, and are lined with sheet iron, the capacity being 1,600 pounds. The tracks have a gauge of 2 feet, and are constructed of steel T rails weighing 12 pounds per running yard. Pivoted iron plates 43 inches in diameter are used as turntables.

### WEIGHING CHARGES.

Granzita and tierras charges are estimated by the known capacity of the cars. The granza cars run over platform scales and the contents are accurately weighed, every charge of ore to be exactly 1,600 pounds.

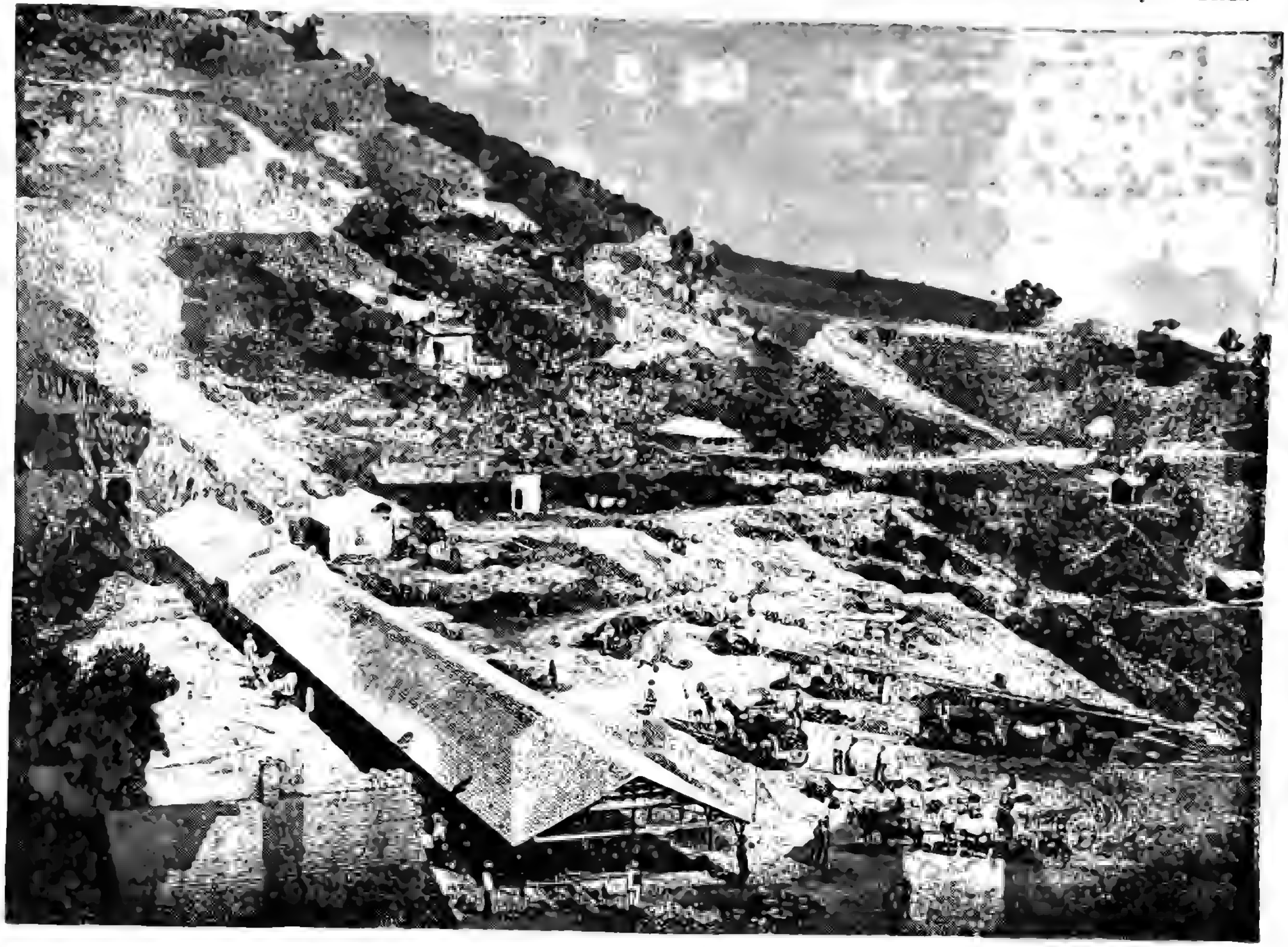
### FURNACE YARD.

The furnace yard, as represented by the accompanying map, consists of about 15 acres, situated in the cañon formed by the Alamitos creek. On either side rise steep hills and rocky bluffs, and about a mile to the west is Mine Hill, which has an elevation of about 1,265 feet above the hacienda. The yard is flat and the bases of the different furnaces and condensers are approximately on the same level. The 2 granzita furnaces, Nos. 1 and 2, are on the east bank of the creek. The others are all on the west bank. The ore tramway from the mine enters on the west and follows along the hillside to the ore bins and screens, which are about 60 feet above the furnace floor.

The floors of the furnace inclosures are paved with brick, and the immediate vicinity of the furnaces, condensers, and weighing rooms are covered with a layer of cement or cement and asphaltum.

There are separate weighing and bottling rooms for each furnace except Nos. 7 and 9, 6 and 8, which have 1 room for each 2 furnaces. The floors are cemented and usually have a slope toward the center, with a small cavity to collect quicksilver if spilled. The weighing rooms contain the quicksilver vats, scales, and a number of flasks. The product of each furnace is kept separate, and the quicksilver in the vats is weighed and flasked once or twice every day. The weighing is done by the watchmen, who keep a record of the number of flasks of quicksilver weighed and sent out and the number on hand in each weighing room, and this account is handed in at the office every night. The flasks of quicksilver are piled up in the weighing room to await shipment or to be transferred to the storehouse.

The flasks now used are secondhand, being bought in the market from shippers. All old flasks require overhauling. They are carefully examined to detect cracks and holes and are then scraped inside to remove iron scales and foreign substances. If necessary, they are retapped and fitted with new stoppers. To remove the oil which they acquire in retapping they are piled in a rectangular heap and subjected to heat. Ordinary quicksilver flasks are about 12 inches long, cylindrical, 5 inches in diameter, made of wrought iron three-eighths inch thick, weigh about 13.5 pounds, and have capacity for 85 to 93 pounds of quicksilver if completely filled, but to allow for



THE PLANILLA, AT THE MOUTH OF THE MAIN TUNNEL, NEW ALMADEN QUICKSILVER MINE.

expansion a fixed quantity of 76.5 pounds is weighed in, making the gross weight of flasks and contents for shipment 90 pounds.

Wood for the furnaces is bought from private parties, who bring it to the hacienda from nearly exhausted forests 15 to 20 miles distant. The wood comes in lengths of 4 feet. For furnaces 7 and 9 the wood is cut by a machine at the hacienda into lengths of 2 feet. The wood is piled in the furnace yard and hauled to the different furnaces as needed. An accurate account of the consumption of wood for each furnace is kept, and the average amount of wood necessary for roasting a ton of ore is computed each month. The kinds of wood used are live oak, tan-bark oak, white oak, redwood, pine, manzanita, and madrone. Live oak is usually preferred to white oak, which is much inferior. Pine is good as fuel, but has rather too much flame and produces soot. Redwood makes good fuel if not more than one year old. Redwood and live oak mixed burn well and with the proper amount of heat and flame.

On account of the soot cleaning it is desirable to obtain a certain quantity of ash, which redwood alone will not produce; hence the reason for mixing it with oak wood.

### RELATIONS WITH LABOR.

The population of New Almaden, depending upon the working of the mines, lives within easy reach of the mine workings, on what is called Mine Hill, on the flat slopes of which the houses and other buildings are grouped along the most accessible places. Near the oldest workings of the old mine is that portion generally inhabited by the Spanish-Americans and called Spanishtown, while farther to the north and east of Mine Hill is the so-called English camp, where the English-speaking population resides. The population numbers about 1,350 persons. Most of these are Mexicans (native Californians), and the next largest percentage is composed of Cornishmen and their offspring. Americans, English, Germans, Swedes, Italians, and a few Chinamen complete the list of nationalities.

Near the reduction works at the foot of Mine Hill is the hacienda, which consists of the furnaces, office, storerooms, workshops, and dwellings of all employés connected with the reduction works. Both places are upon the lands of the Quicksilver Mining Company, and all local arrangements and sanitary matters are therefore largely under the controlling influence of the mine manager.

The educational interests are taken care of by the state school department. A very neat schoolhouse in the English camp and a smaller one in the Spanish camp are under the direction of a principal and 3 lady teachers, and another is located at the hacienda, under the management of 1 or 2 teachers. The Quicksilver Mining Company does all in its power to foster and assist these interests. At the enumeration for the Eleventh Census there were reported 333 children between 6 and 17 years of age on the hill and 85 children at the hacienda. The average attendance is about 80 per cent in all the schools. During the last year "technical schools" were established at both settlements, furnishing instruction in blacksmithing and carpenter work for the boys and sewing and plain cooking for the girls. Although these schools were open only during the term of vacation in the public schools, very gratifying results were obtained.

There is a Catholic church in Spanishtown and a Methodist Episcopal church at the English camp. A Methodist minister resides at the camp. The Catholic church is attended on Sundays and great holidays by a priest not resident at the place. These churches were built with the aid of private contributions, assisted by the company and manager.

Only 1 saloon is permitted on the hill, and it is allowed to sell only beer and wine, other intoxicating liquors being excluded.

Benevolent institutions are of a private nature. The Englishmen have a mutual benevolent society, the members of which succor each other in times of need or sickness, and the Mexicans have 3 similar societies, called the Guadalupe society (Nuestra Señora de Guadalupe), organized February 1, 1873, and reformed in May, 1886, and the Hidalgo and Philanthropico societies.

The sanitary department is represented by a resident physician and surgeon, assisted by a competent druggist and a complete drug store. This is under the so-called miners' fund of New Almaden, established by general consent in 1870. The rules and regulations of this institution are in substance as follows:

I. Employés of the Quicksilver Mining Company, heads of families, and all other adults residing at New Almaden each pay $1 monthly into said fund. The money so contributed is held by a trustee, to be paid out for the following purposes: first, the salaries of a resident physician and druggist and for the purchase of medical supplies; second, for the relief of contributors whom circumstances may entitle to the same, and for other contingent expenses.

II. Contributors are entitled, without further payment, to the attendance of the resident physician for themselves and their immediate families, except that in cases of confinement the sum of $5 is charged, and medicines are prescribed and furnished on payment of cost.

III. When the fund is subject to any expense for relief of persons indigent or otherwise, as for medicines, nurses, and supplies, it will be regarded in the nature of a gift or as an advance to be repaid, as the trustee may decide to be just, considering the circumstances of each case.

IV. It is expressly agreed that when the resident physician is called to attend any person not a contributor to the fund there shall be a charge of not less than $5 for each visit, to be paid into the fund and to be charged against and collected from the head of the house where such noncontributor may be living.

V. The trustee serves without pay, and in consideration thereof it is understood that the foregoing rules and regulations will be observed by all persons interested therein; and it is expressly agreed that all sums due or to become due to the fund by contributors, or any of them, shall be a lien upon any property of the contributors at New Almaden and upon any money due or to become due them for wages from the Quicksilver Mining Company, which money the company is authorized to pay over to the fund without further notice.

HOSPITALS.—2 hospitals are provided, 1 in the English camp and 1 in Spanishtown, although their use is very rarely required. Nurses are paid from the miners' fund. An employé receiving an injury while on duty or at his work is supplied with medical or surgical supplies without cost, and nurses and sustenance are furnished if necessary, or support given his family during his illness and incapacity for work. Cases of destitution from ordinary sickness or other causes are deservedly considered.

The physician makes a monthly report of (1) the number of visits made each month, (2) the number of office prescriptions, (3) the number of vaccinations, (4) the number of obstetrical cases, (5) the number of cases of salivation. The druggist, who is also a clerk for the mine, makes up the prescriptions, for which he is paid an allowance of $25 per month. The accounts and collections are made by the bookkeeper of the hacienda. He also receives a compensation of $25 per month.

The company provides stabling for the physician's saddle horse, and all the necessary buildings for offices, hospitals, dispensary, and dwelling house for the physician, free of expense.

The report of the physician for the year ended November 30, 1890, is given below. The table treats only of the employés at the mine and at the reduction works. A statement on the following page deals with the entire population residing on the lands of the company.

PHYSICIAN'S REPORT AT NEW ALMADEN FOR THE YEAR 1890.

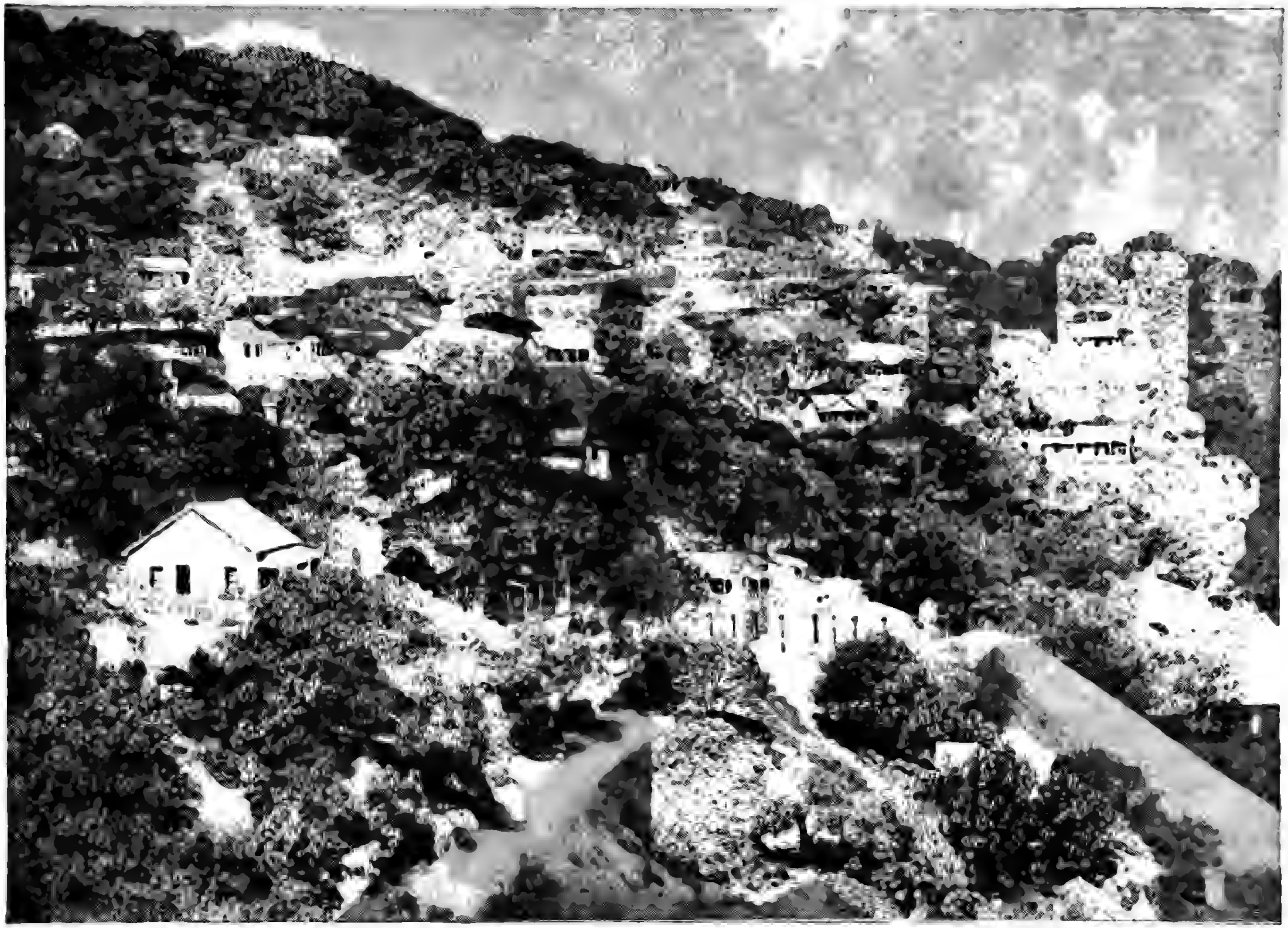
| ITEMS. | MINE. | | WORKS. | |
|---|---|---|---|---|
| | Number. | Per cent. | Number. | Per cent. |
| Average number of employés | 316 | .......... | 47 | .......... |
| Number and per cent of cases of mercurialism | 33 | 10.44 | .......... | .......... |
| Number and per cent of serious accidents | 5 | 1.58 | .......... | .......... |
| Number and per cent of new cases | 267 | 84.50 | 55 | 117.02 |
| Total new cases of all kinds | 305 | 96.52 | 55 | 117.02 |
| Deaths | 3 | a9.49 | .......... | .......... |

a Per thousand.

The above table shows a decided difference in the salivation rate at the mine in comparison with that at the works, and, being so remarkable, is well worthy an inquiry as to its cause. This difference may in a measure be explained as follows: the miners employed in the extraction of ore work by contract as a rule, and a certain number of careless men, through their own negligence, become victims to mercurial salivation. Men engaged in ore chambers where native mercury is found are requested not to eat, drink, or smoke without first cleaning the face and hands and using a solution of potassium chlorate as a mouth wash. Working stripped to the waist is discouraged.

As the greatest attention is paid toward the attainment of perfect ventilation, which is of prime importance in the prevention of mercurial sickness, it is the physician's belief that if the miners were more thorough in the use of the above precautions the salivation rate at the mine would be under 1 per cent, whereas it is now over 10 per cent It is probable that there will always be a slight amount of mercurial sickness, owing, very likely, to the suspension in the moist atmosphere of the mine of a small amount of the chlorides and possibly other salts of mercury. The absolute immunity from mercurialism of the men employed at the reduction works may be explained on the following grounds, viz: to the thorough sealing of furnaces, condensers, and flues; to the use of forced draft by means of fans; to the discontinuance of soot-cleaning by hand; to the medical prophylaxis, which consists solely in the use of a saturated solution of potassium chlorate as a mouth wash after the slightest exposure to mercurial vapor or other noxious fumes; to the employment at the works of a careful, faithful, and comparatively temperate class of men, this last characteristic being in no small degree responsible for the absence of mercurial sickness; lastly, to the increasing experience now obtaining in the proper reduction of quicksilver ores, and to the efforts on the part of the management to secure absolute immunity from mercurial salivation through the use of the most approved apparatus and appliances. There were but 5 accidents of a serious nature, all of them being fractures, none of which proved fatal.

The high and greatly abnormal sick rate was due to the prevalence of the grippe epidemic in the winter of 1889 and spring of 1890, yet no fatal cases resulted therefrom. The 3 deaths reported as occurring at New Almaden



HILLSIDE COTTAGES, ENGLISH CAMP, NEW ALMADEN QUICKSILVER MINES.

mine were caused by parenchymatous nephritis, pyæmia, and erysipelas following a gunshot wound. A special census taken during December, 1890, gives the information contained in the following table:

SPECIAL CENSUS AT NEW ALMADEN IN 1890.

| ITEMS. | Total. | SPANISH-AMERICAN. | | | | ANGLO-AMERICAN AND OTHERS. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Over 5 years. | | 5 years and under. | | Over 5 years. | | 5 years and under. | |
| | | Male. | Female. | Male. | Female. | Male. | Female. | Male. | Female. |
| Hill (mine) | 1,132 | 282 | 190 | 47 | 42 | 283 | 214 | 39 | 35 |
| Hacienda (works) | 223 | 24 | 22 | 4 | 6 | 91 | 57 | 11 | 8 |
| Total | 1,355 | 306 | 212 | 51 | 48 | 374 | 271 | 50 | 43 |
| Number of deaths | 25 | 4 | 6 | 7 | 2 | 1 | 2 | 2 | 1 |
| Number of births | 48 | ........ | 28 | ........ | ........ | ........ | 20 | ........ | ........ |

The analysis of this table shows the following death rate:

DEATH RATE AT NEW ALMADEN IN 1890.

| | PER 1,000. |
|---|---|
| Spanish-American | 30.8 |
| Anglo-American (including other nationalities) | 8.1 |
| Average death rate | 18.5 |

BIRTH RATE AT NEW ALMADEN IN 1890.

| | PER 1,000. |
|---|---|
| Spanish-American | 45.4 |
| Anglo-American (including other nationalities) | 27.1 |
| Average birth rate | 35.4 |

The difference in the mortality rate between the Spanish-Americans and the Anglo-Americans, which includes some of other nationalities, is noteworthy, as the 2 classes are living under similar climatic conditions; yet tubercular disease is very common with the former class and caused 10 deaths, while with the latter class not a single case is to be remarked. The diseases which caused death were tuberculosis, 10; cholera infantum, 3; capillary bronchitis, cancer, peritonitis, laryngismus (stridulous), meningitis, erysipelas, tetanus, nephritis, diphtheria, pyæmia, and injuries following a burn, 1 each. Excepting the grippe and measles, no disease has been epidemic during the past year, a fact which serves as a criterion of the excellent hygienic conditions at present existing.

THE HELPING HAND.—A social organization, called the Helping Hand Club, for which the company built and fitted up comfortable houses, on the hill as well as at the hacienda, induces pleasant intercourse among the inhabitants. The hall building at the hacienda is a modern structure in very attractive style, having on its lower floor a large assembly hall and stage for concerts or other entertainments, adjoined by reading and dressing rooms, while the upper floor is divided into 4 bedrooms, for the use of visitors or guests at the reduction works. On the hill the building consists of a large assembly hall, with stage and dressing rooms, a reading room, and kitchen, all on one floor. Both halls are provided with pianos, purchased by the club managers with surplus funds from entertainments given, and the reading rooms have small libraries besides a list of monthly magazines and the best daily and weekly newspapers. The halls are warmed and lighted by the company, and admission is free to all residents at the mine and reduction works who are employés of the company. Entertainments of musical or dramatic character are here given by the club members, and at other times the halls are provided with card tables, where the members may enjoy a pleasant game of checkers, chess, or cards. Every encouragement is given to residents for domestic or public comfort, and the result of this patriarchal régime is seen in the fact that many of the miners have worked here uninterruptedly for 30 years or more; some, in fact, have been born on the soil, are now heads of families, and consider the mine their home for life.

The great majority of the workmen are married and have families, and this class of labor is encouraged and fostered as much as possible, as it forms a more reliable and responsible element than could be had by engaging single men without domestic ties, liable to roam at any moment. It is hardly necessary to add that strikes have never occurred, and are not likely to occur as long as this reciprocated feeling of trust and good will exists between the management and the employés.

The single men employed are boarded and lodged in boarding houses, of which there are 2 on the hill, 1 for the English speaking and 1 for Spanish men. Both are large, substantial dwellings with all the comforts of domestic life, large, well-ventilated dining rooms and sleeping rooms neatly furnished, while there are in the basement rooms in which to change and dry the damp clothing brought from the mine. At the hacienda a similar boarding house, furnished by the company, is kept for single men or visitors. The sleeping rooms for workmen are arranged in a separate building, a similar one being also on the hill.

HOURS OF WORK.—The hours of work on the surface are from 7 o'clock in the morning until 6 o'clock in the evening, allowing 1 hour at noon for dinner or lunch. Miners go into the mine at 7 o'clock in the morning and evening and leave the mine at 5 in the evening and morning, respectively. 1 hour at noon and midnight is allowed for lunch and rest, which, allowing half an hour's time to reach their working places and as much for returning to the surface, makes 8 hours of solid work in the mine.

On Sundays and national holidays work is stopped in the mines and on the surface, except at the pumps of the Buena Vista shaft, which are continued without interruption.

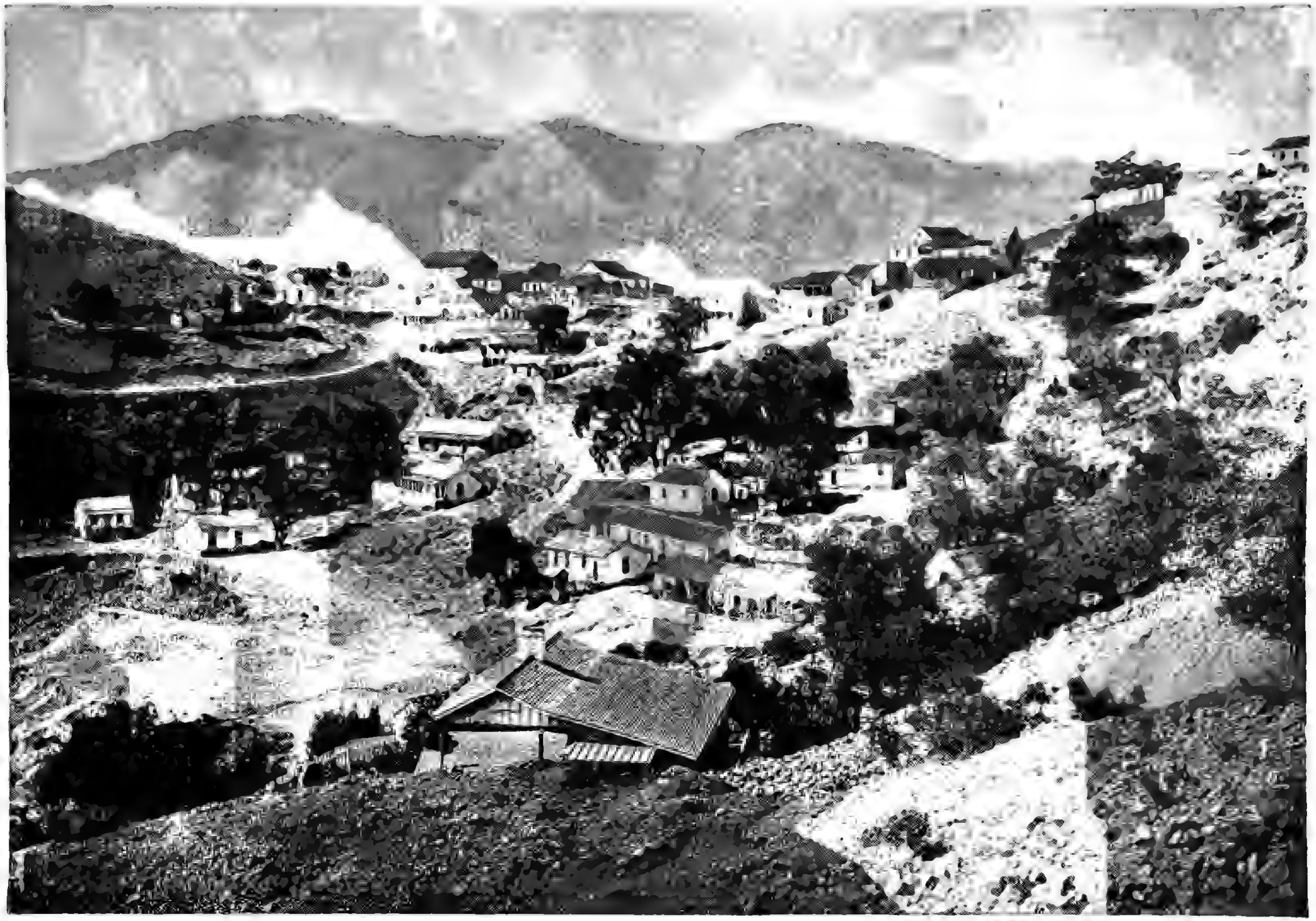
## PRODUCTION OF QUICKSILVER AT NEW ALMADEN.

Up to August 31, 1863, the New Almaden mines had produced 23,619,834 pounds of quicksilver, equal to 308,756 flasks of 76.5 pounds each, from 51,157 short tons of ore, or 461.7 pounds to the ton, an average of 23.09 per cent. Including the above, the total to the close of 1889 amounted to 69,191,113.5 pounds, or 904,459 flasks.

### PRODUCT OF QUICKSILVER AT NEW ALMADEN FOR 37 YEARS AND 3 MONTHS.

| DATES. | Total pounds of ore roasted. | Total flasks of quicksilver produced. | Yield of quicksilver. (Per cent.) |
|---|---|---|---|
| Total and average | 1, 262, 789, 640 | [a]893, 888 | 5. 41 |
| July, 1850, to June, 1851 | 4, 970, 717 | 23, 875 | 36. 74 |
| July, 1851, to June, 1852 | 4, 643, 290 | 19, 921 | 32. 82 |
| July, 1852, to June, 1853 | 4, 839, 520 | 18, 035 | 28. 51 |
| July, 1853, to June, 1854 | 7, 448, 000 | 26, 325 | 27. 04 |
| July, 1854, to June, 1855 | 9, 109, 300 | 31, 860 | 26. 76 |
| July, 1855, to June, 1856 | 10, 355, 200 | 28, 083 | 20. 75 |
| July, 1856, to June, 1857 | 10, 299, 900 | 26, 002 | 19. 31 |
| July, 1857, to June, 1858 | 10, 997, 170 | 29, 347 | 20. 41 |
| July, 1858, to October, 1858 | 3, 873, 085 | 10, 588 | 20. 91 |
| November, 1858, to January, 1861 | .............. | ............ | .......... |
| February, 1861, to January, 1862 | 13, 323, 200 | 34, 765 | 19. 96 |
| February, 1862, to January, 1863 | 15, 281, 400 | 40, 391 | 20. 22 |
| February, 1863, to August, 1863 | 7, 172, 660 | 19, 564 | 20. 87 |
| September, 1863, to October, 1863 | 2, 346, 000 | 5, 520 | 18. 00 |
| November, 1863, to December, 1863 | 2, 359, 300 | 4, 447 | 14. 42 |
| January, 1864, to December, 1864 | 23, 277, 600 | 42, 489 | 13. 96 |
| January, 1865, to December, 1865 | 31, 948, 400 | 47, 194 | 11. 30 |
| January, 1866, to December, 1866 | 26, 885, 300 | 35, 150 | 10. 00 |
| January, 1867, to December, 1867 | 26, 023, 933 | 24, 461 | 7. 19 |
| January, 1868, to December, 1868 | 29, 405, 530 | 25, 628 | 6. 67 |
| January, 1869, to December, 1869 | 25, 458, 175 | 16, 898 | 5. 08 |
| January, 1870, to December, 1870 | 21, 097, 700 | 14, 423 | 5. 23 |
| January, 1871, to December, 1871 | 22, 034, 700 | 18, 568 | 6. 45 |
| January, 1872, to December, 1872 | 21, 416, 600 | 18, 574 | 6. 63 |
| January, 1873, to December, 1873 | 17, 330, 375 | 11, 042 | 4. 87 |
| January, 1874, to December, 1874 | 23, 454, 000 | 9, 084 | 2. 96 |
| January, 1875, to December, 1875 | 31, 106, 200 | 13, 648 | 3. 36 |
| January, 1876, to December, 1876 | 33, 316, 950 | 20, 549 | 4. 72 |
| January, 1877, to December, 1877 | 37, 231, 300 | 23, 996 | 4. 93 |
| January, 1878, to December, 1878 | 36, 942, 225 | 15, 852 | 3. 28 |
| January, 1879, to December, 1879 | 55, 065, 135 | 20, 514 | 2. 85 |
| January, 1880, to December, 1880 | 61, 354, 850 | 23, 465 | 2. 93 |
| January, 1881, to December, 1881 | 64, 141, 135 | 26. 060 | 3. 11 |
| January, 1882, to December, 1882 | 72, 147, 200 | 28, 070 | 2. 98 |
| January, 1883, to December, 1883 | 77, 162, 500 | 29, 000 | 2. 88 |
| January, 1884, to December, 1884 | 79, 251, 000 | 20, 000 | 1. 93 |
| January, 1885, to December, 1885 | 79, 069, 300 | 21, 400 | 2. 07 |
| January, 1886, to December, 1886 | 81, 398, 690 | 18, 000 | 1. 69 |
| January, 1887, to December, 1887 | 64, 151, 300 | 20, 000 | 2. 38 |
| January, 1888, to December, 1888 | 57, 325, 600 | 18, 000 | 2. 40 |
| January, 1889, to December, 1889 | 57, 775, 200 | 13, 100 | 1. 73 |

[a] Additional product of Enriquita mine from 1860 to 1863, 10,571 flasks.



MEXICAN CAMP NEW ALMADEN QUICKSILVER MINES

## WAGES AT NEW ALMADEN IN 1889.

| EMPLOYÉS. | Per month. | Per day. |
|---|---|---|
| MINE. | | |
| Machinists | $100.00 | |
| Machinist's helpers | $60.00 to 75.00 | |
| Engine drivers | 70.00 to 80.00 | |
| Firemen | 40.00 to 60.00 | |
| Blacksmiths | 45.00 to 60.00 | |
| Blacksmiths' helpers | 30.00 to 35.00 | |
| Pumpmen | 71.00 to 90.00 | |
| Shaftmen | 71.00 | |
| Blasters | 71.00 | |
| Boilermakers | | $2.00 to $2.50 |
| Timbermen (shaftmen) | | 2.00 to 2.50 |
| Carpenters | | 3.00 |
| Surface laborers | | 1.50 to 2.00 |
| Ore cleaners | | 1.75 to 2.00 |
| Laborers in labores | | 1.50 to 2.00 |
| Trammers | | 1.75 to 2.25 |
| Skip fillers | | 2.00 |
| Landers | | 1.25 to 1.75 |
| Boys | | 1.00 to 1.50 |
| HACIENDA. | | |
| Furnace foremen | 100.00 | |
| Weighers | 85.00 | |
| Machinists | 70.00 to 100.00 | |
| Mason | 150.00 | |
| Blacksmith | | 3.00 |
| Blacksmiths' helpers | | 1.25 to 2.00 |
| Carpenters | | 3.00 |
| Engine drivers | 50.00 | |
| Laborers | | 2.00 to 2.25 |
| Furnacemen (trammers) | | 2.00 |
| Furnacemen (firemen and chargers) | | 2.50 |
| Sootmen | | 2.10 |
| Transportation, 2-horse teams | | 4.00 |
| Transportation, 4-horse teams | | 6.00 |

## SUPPLIES CONSUMED DURING THE YEAR 1889.

| ITEMS. | At mine. | At hacienda. |
|---|---|---|
| Total | $54,855.15 | $31,573.33 |
| Bricks | 1.20 | 38.99 |
| Candles and oils | 1,816.40 | 778.31 |
| Castings and foundry work | 144.25 | 743.93 |
| Coal | 19,539.63 | 2,346.51 |
| Hay and grain | 1,031.67 | 2,064.40 |
| Iron, steel, and hardware | 3,128.40 | 1,062.77 |
| Lagging | 1,557.24 | |
| Lime and cement | 24.77 | 82.77 |
| Lumber and timber | 17,247.26 | 2,167.39 |
| Powder, fuse, and caps | 2,081.17 | |
| Railroad iron | 339.20 | 28.06 |
| Sundries | 2,273.30 | 1,607.85 |
| Wood | 5,670.66 | 13,738.24 |
| Flasks | | 6,914.11 |

## DRIFTING, SINKING, AND PROSPECTING ("DEAD WORK") AT NEW ALMADEN.

| | FEET. | | FEET. |
|---|---|---|---|
| 1880 | 5,144.79 | 1886 | 11,926.00 |
| 1881 | 4,574.25 | 1887 | 10,766.50 |
| 1882 | 9,133.00 | 1888 | 9,582.00 |
| 1883 | 6,699.50 | 1889 | 10,169.00 |
| 1884 | 6,814.50 | | |
| 1885 | 11,370.50 | Total | 86,180.04 |

TABLE SHOWING AMOUNT AND COST OF PRODUCTION OF ORE AND QUICKSILVER AND OF PROSPECT WORK AT NEW ALMADEN, 1880 TO 1889, INCLUSIVE.

| YEARS. | Total tons of rock, vein matter, and ore extracted from the mine. | Total tons of granza ore shipped to reduction works. | Total tons of tierras ore shipped to reduction works. | Total tons of all ore shipped to reduction works. | Total tons of all descriptions of ore roasted. | Flasks of quicksilver of 76.5 pounds each produced. |
|---|---|---|---|---|---|---|
| Total | 1,109,770.28 | 73,916.89 | 263,088.66 | 337,005.55 | 346,888.39 | 217,095 |
| 1880 | 83,666.79 | *a*7,527.67 | *b*4,145.30<br>*a*12,125.50 | 23,798.47 | 30,677.43 | 23,465 |
| 1881 | 90,295.65 | *a*8,020.75 | *b*11,697.70<br>*a*14,097.50 | 33,815.95 | 32,070.57 | 26,060 |
| 1882 | 120,222.57 | *a*9,236.43 | *b*10,274.00<br>*a*14,705.81 | 34,216.24 | 36,073.60 | 28,070 |
| 1883 | 117,579.45 | *a*9,584.20 | *b*11,214.32<br>*a*20,289.24 | 41,087.76 | 38,581.25 | 29,000 |
| 1884 | 126,139.61 | *b*8.00<br>*a*7,624.23 | *b*11,596.79<br>*a*20,038.20 | 39,267.22 | 39,625.50 | 20,000 |
| 1885 | 138,639.52 | *b*81.37<br>*a*8,484.77 | *b*4,010.59<br>*a*25,039.91 | 37,616.64 | 39,534.65 | 21,400 |
| 1886 | 120,398.85 | *b*183.70<br>*a*7,183.96 | *b*5,900.61<br>*a*24,717.72 | 37,985.99 | 40,699.34 | 18,000 |
| 1887 | 115,004.15 | *b*60.52<br>*a*6,214.52 | *b*7,114.95<br>*a*19,642.95 | 33,032.94 | 32,075.65 | 20,000 |
| 1888 | 99,166.54 | *b*22.18<br>*a*5,060.95 | *b*4,896.82<br>*a*18,196.44 | 28,176.39 | 28,662.80 | 18,000 |
| 1889 | 98,657.15 | *b*24.59<br>*a*4,599.05 | *b*3,605.75<br>*a*19,778.56 | 28,007.95 | 28,887.60 | 13,100 |

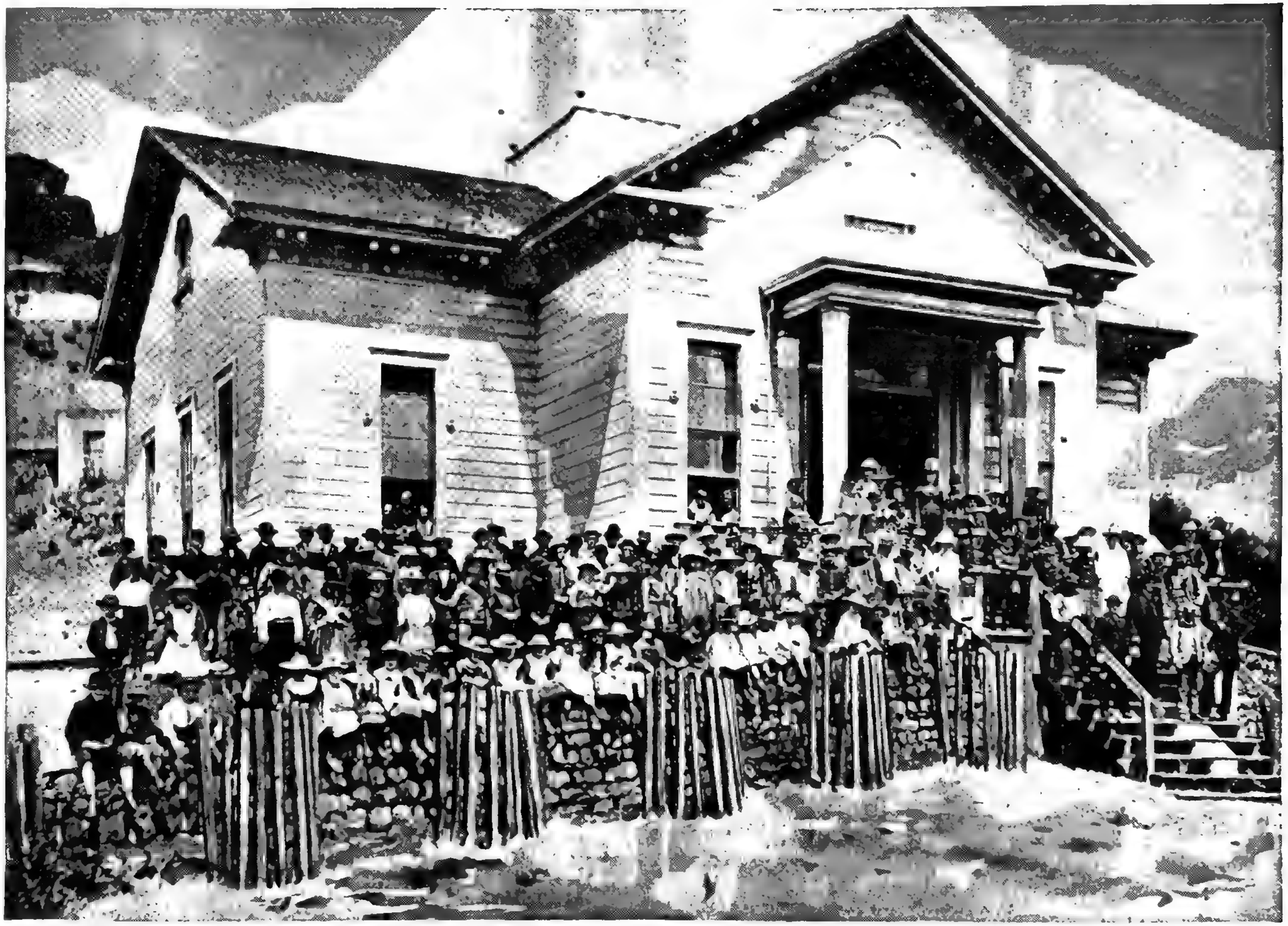
| YEARS. | Average yield of all ores roasted. (Per cent.) | Cost per ton for mine supplies, timber, powder, fuse, iron, steel, lagging, candles and oils, railroad iron, and sundries. | Cost for labor per ton for all matter mined. | Cost per ton for all ore delivered at the furnaces; labor, supplies, and transportation. | Cost per flask, embracing all expenses, less receipts from rentals and other sources. (*c*) | Number of yards drifted, sunk, etc. | Average price paid per yard, not including supplies. |
|---|---|---|---|---|---|---|---|
| Total and averages | 2.39 | $0.69 | $2.38 | $10.46 | $21.09 | 28,110.32 | $23.61 |
| 1880 | 2.93 | 0.62 | 2.22 | 10.40 | 15.25 | 1,714.93 | 22.30 |
| 1881 | 3.11 | 0.55 | 2.11 | 7.37 | 13.35 | 1,524.75 | 30.61 |
| 1882 | 2.98 | 0.59 | 2.29 | 10.45 | 17.13 | 3,043.63 | 26.69 |
| 1883 | 2.88 | 0.65 | 2.16 | 8.34 | 16.10 | 2,006.87 | 25.52 |
| 1884 | 1.93 | 0.74 | 2.15 | 9.62 | 24.00 | 1,836.53 | 29.27 |
| 1885 | 2.07 | 0.88 | 2.34 | 12.23 | 26.75 | 3,871.58 | 25.30 |
| 1886 | 1.69 | 0.82 | 2.66 | 11.33 | 29.14 | 3,954.18 | 22.25 |
| 1887 | 2.38 | 0.71 | 2.59 | 11.82 | 24.75 | 3,553.82 | 23.76 |
| 1888 | 2.40 | 0.71 | 2.81 | 12.76 | 25.24 | 3,276.45 | 21.65 |
| 1889 | 1.73 | 0.55 | 2.49 | 11.10 | 30.41 | 3,327.58 | 16.96 |

*a* From mine proper. *b* From surface workings. *c* Does not include increase or decrease of ore account at hacienda.

## THE PRODUCTION OF VERMILION.

As the result of inquiries made, it was reported that 6 manufacturing establishments in the city of New York consumed in 1889 535,728 pounds of quicksilver, equal to about 7,003 flasks, in the manufacture of 600,047 pounds of vermilion.

The manufacturers of mercurial preparations absolutely declined to give any account of the quicksilver consumed in the manufacture of their several products, on the ground that it was impossible to separate the figures, but after much difficulty the aggregate amount of quicksilver consumed by 2 firms was ascertained to be, respectively, 750 and 1,754 flasks. As the desired information could not be acquired from all the manufacturers, the foregoing statement of consumption is only an approximation.



HILL SCHOOL, NEW ALMADEN QUICKSILVER MINES.

## CONSUMPTION OF QUICKSILVER IN MILLING GOLD AND SILVER ORES.

The following statement has been prepared, after special study of the mines mentioned, to show the quantity of quicksilver consumed in gold and silver milling. The limits are very great, due partly, of course, to the great difference in character of the ores treated, but very greatly also to skill in mill practice.

### CONSUMPTION OF QUICKSILVER PER TON OF ORE WORKED.

| YEARS. | Mines. | States and territories. | Number of mills. | Ore worked. (Tons.) | Quicksilver consumed. (Pounds.) | Quicksilver consumed. (Pounds per ton.) |
|---|---|---|---|---|---|---|
| 1889 | Bimetallic (silver) | Montana | 1 | 23, 215 | 43, 528 | 1. 87 |
| 1889 | Elkhorn (silver and lead) | ...do | 1 | 8, 712 | 13, 387 | 1. 54 |
| 1889 | Hope | ...do | 1 | 6, 634 | 8, 803 | 1. 33 |
| 1887 | ...do | ...do | 1 | 8, 091 | 7, 889 | 0. 98 |
| 1888 | ...do | ...do | 1 | 8, 962 | 9, 231 | 1. 03 |
| 1885 | Montana (limited) (gold and silver) | ...do | 1 | 33, 482 | 46, 545 | 1. 39 |
| 1886 | ...do | ...do | 1 | 41, 728 | 50, 235 | 1. 20 |
| 1887 | ...do | ...do | 1 | 75, 005 | 48, 434 | 0. 65 |
| 1888 | ...do | ...do | 1 | 83, 745 | 21, 503 | 0. 26 |
| 1889 | ...do | ...do | 1 | 78, 749 | 38, 638 | 0. 49 |
| 1889 | Ontario (silver and lead) | Utah | 1 | 34, 733 | 35, 580 | 1. 02 |
| 1886–1889 | Blue Bird (silver) | Montana | 1 | 103, 076 | 85, 474 | 0. 83 |
| 1884–1889 | Granite Mountain (silver) | ...do | 1 | 120, 000 | 96, 000 | 0. 80 |
| 1883 | Lexington (gold and silver) | ...do | 1 | 20, 281 | 16, 667 | 0. 82 |
| 1884 | ...do | ...do | 1 | 22, 138 | 13, 120 | 0. 59 |
| 1835 | ...do | ...do | 1 | 20, 749 | 16, 141 | 0. 78 |
| 1886 | ...do | ...do | 1 | 21, 379 | 6, 688 | 0. 31 |
| 1887 | ...do | ...do | 1 | 23, 789 | 9, 678 | 0. 41 |
| 1888 | ...do | ...do | 1 | 24, 594 | 13, 594 | 0. 55 |
| 1889 | ...do | ...do | 1 | 26, 361 | 13, 497 | 0. 51 |
| 1888–1889 | Empire (gold) | California | 1 | .......... | .......... | 0. 06 |
| 1888 | North Star | ...do | 1 | 17, 259 | 842 | 0. 05 |
| 1889 | ...do | ...do | 1 | 20, 525 | 995 | 0. 05 |
| 1889 | Treadwell | Alaska | 1 | 218, 000 | 2, 725 | 0. 01 |
| 1880–1890 | Homestake | South Dakota | 1 | 2, 159, 011 | 14, 536 | 0. 01 |
| 1880–1890 | Idaho (gold and silver) | California | 1 | 278, 830 | 7, 879 | 0. 03 |

At the Bimetallic mine, in Montana, the ore is base silver. It all requires roasting. The average composition of the ore is as follows:

### AVERAGE COMPOSITION OF ORE FROM THE BIMETALLIC MINE, MONTANA.

|  | PER CENT. |  | PER CENT. |
|---|---|---|---|
| Silica | 64. 50 | Arsenic | 1. 53 |
| Iron | 7. 70 | Antimony | 0. 55 |
| Manganese | 2. 52 | Zinc | 5. 80 |
| Lime | 2. 70 | Silver | 3. 07 |
| Sulphur | 8. 45 |  |  |
| Lead | 2. 73 | Total | 100. 00 |
| Copper | 0. 45 |  |  |

The ore of the Montana (limited) mine contains gold and silver in the proportion of about 64 per cent gold and 36 per cent silver. The gangue is quartz, with a small quantity of broken slate. The ore is free milling, and is treated by the "combination process" of amalgamation before concentration. The principal base in the quartz is copper, of which there is a slight amount, as well as a trace of lead and a very small percentage of manganese.

At the Ontario mine in Utah the country rock is quartzite and limestone; the gangue is quartz; fahlore is the principal silver-bearing mineral, containing galena, zinc blende, copper, and iron pyrites, carrying comparatively little silver and a trace of gold. Near the surface, and also in many portions of the mine below the water level, the sulphurets are more or less decomposed and oxidized. The ore first mined was free milling. At present all the ore has to be subjected to a chloridizing roasting before amalgamation.

There are 2 classes of ore shipped from the Ontario mine. The first, containing from 70 to 80 ounces of silver and from 10 to 12 per cent lead per ton, is sold to the smelters; the second, containing from 35 to 50 ounces silver per ton, with a small percentage of lead, is reduced at the home mill. The percentage of copper and zinc in the ore varies more or less, and has never been accurately determined.

At the Lexington mine, Montana, the gangue is quartz. The ore averages 1 ounce in gold and 50 ounces of silver. The process of reduction is dry crushing, chloridizing, roasting, and amalgamating in pans. Other metals are iron, copper, lead, and zinc as sulphurets, in various proportions, the average being for these sulphurets about

10 per cent, with from 10 to 20 per cent of other gangue material, not quartz, consisting of manganese spar and calc-spar.

The Empire mine, California, has a quartz gangue. The ore is free-milling gold. There are no other metals to speak of in the gangue matter.

The Idaho mine, California, has quartz for the gangue, and the ore yields gold and silver combined; gold about 85.4 to silver 14.6. It is free milling. There are no other metals of value.

At the Granite Mountain mine the ore contains silver, with about one-tenth of an ounce per ton of gold. The ore is refractory, requiring roasting in order to be chloridized and desulphurized. The contents of the average ore are about as follows:

COMPOSITION OF GRANITE MOUNTAIN ORE.

| | PER CENT. | | PER CENT. |
|---|---|---|---|
| Silica | 80 | Sulphur | 8 |
| Iron | 6 | Zinc | 2 |
| Arsenic | 2 | Antimony | 1 |
| Copper | Trace. | | |

The zinc, iron, etc., are found in the form of sulphides. The vein matter, outside of the quartz, is mostly decomposed granite.

The Hope mine, Montana, yields silver ore—no gold. It is free milling, not roasted; contains manganese in varying quantities, usually a small percentage. The gangue is blocky quartz, with sulphurets and chloride of silver, between yellow limestone walls, with yellow clay on the hanging wall.

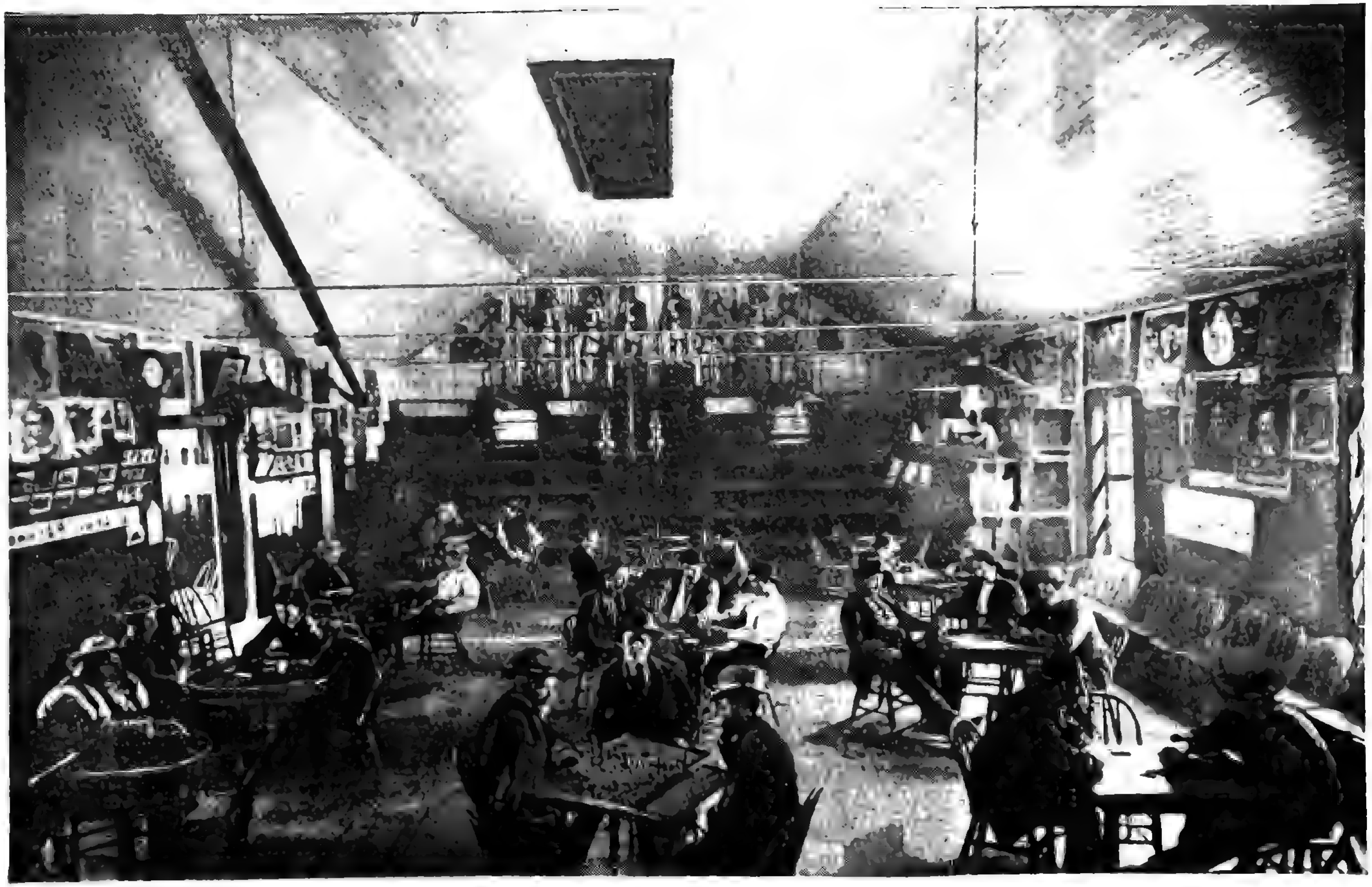
### CONSUMPTION OF QUICKSILVER ON THE COMSTOCK LODE, NEVADA.

The following table gives the tons of Comstock ore worked, the amount of quicksilver consumed for each year, and the average number of pounds of quicksilver consumed per ton of ore worked for the period stated. The table does not include all the working mills for the several years given, but does include nearly all those mills that have kept reliable data. These mills were located in Storey, Lyon, and Ormsby counties, in Nevada.

CONSUMPTION OF QUICKSILVER IN MILLING THE ORES OF THE COMSTOCK LODE.

| YEARS. | Number of mills. | Ore worked. (Tons.) | Quicksilver consumed. (Pounds.) | Quicksilver consumed per ton. (Pounds.) |
|---|---|---|---|---|
| Total | 50 | 1, 268, 083 | 2, 498, 248 | 1. 97 |
| 1880 | 6 | 130, 578 | 246, 347 | 1. 89 |
| 1881 | 4 | 47, 890 | 91, 352 | 1. 91 |
| 1882 | 4 | 81, 110 | 142, 665 | 1. 76 |
| 1883 | 5 | 95, 993 | 176, 201 | 1. 84 |
| 1884 | 3 | 83, 120 | 157, 646 | 1. 90 |
| 1885 | 3 | 78, 689 | 131, 934 | 1. 68 |
| 1886 | 5 | 192, 837 | 371, 570 | 1. 93 |
| 1887 | 6 | 159, 666 | 387, 655 | 2. 43 |
| 1888 | 7 | 195, 203 | 415, 077 | 2. 13 |
| 1889 | 7 | 202, 997 | 377, 801 | 1. 86 |

The table following gives the tons of Comstock tailings worked, the amount of quicksilver consumed for each year, and the average number of pounds of quicksilver consumed per ton of ore worked for the period stated. In addition to the remarks for the ore table, it may be stated that the results are not so uniform, due doubtless to the presence at times of foreign matter that sometimes unavoidably gets into the tailings during the rainy season, and other causes not known. The percentage of loss is less, because the tailings already hold quicksilver.



"HELPING HAND" CLUB ROOM. NEW ALMADEN QUICKSILVER MINES.

### CONSUMPTION OF QUICKSILVER IN WORKING COMSTOCK TAILINGS.

| YEARS. | Number of mills. | Ore worked. (Tons.) | Quicksilver consumed. (Pounds.) | Quicksilver consumed per ton. (Pounds.) |
|---|---|---|---|---|
| Total | 22 | 400, 075 | 368, 920 | 0. 92 |
| 1880 | 4 | 104, 056 | 86, 680 | 0. 83 |
| 1881 | 5 | 68, 714 | 44, 451 | 0. 65 |
| 1882 | 3 | 42, 583 | 43, 987 | 1. 03 |
| 1883 | 2 | 19, 514 | 34, 346 | 1. 76 |
| 1884 | 2 | 39, 871 | 38, 960 | 0. 98 |
| 1885 | 2 | 29, 527 | 23, 945 | 0. 81 |
| 1886 | 1 | 31, 164 | 32, 752 | 1. 05 |
| 1887 | 1 | 19, 806 | 17, 694 | 0. 89 |
| 1888 | 1 | 24, 154 | 24, 585 | 1. 02 |
| 1889 | 1 | 20, 686 | 21, 520 | 1. 04 |

The following table includes all the quicksilver shipped over the Virginia and Truckee railroad into Nevada during the period from 1880 to 1889, both years inclusive. The number of flasks was not reported by the railroad officials at Carson, only the tons and pounds, and the flask has been taken as weighing 90 pounds, gross.

### QUICKSILVER SHIPPED OVER THE VIRGINIA AND TRUCKEE RAILROAD, NEVADA, FOR 10 YEARS.

| YEARS. | Tons and pounds. | | Total in pounds. | Flasks. |
|---|---|---|---|---|
| Total | 2, 156 | 66 | 4, 312, 066 | 47, 912 |
| 1880 | 110 | 1, 800 | 221, 800 | 2, 464 |
| 1881 | 119 | 1, 554 | 239, 554 | 2, 662 |
| 1882 | 120 | 1, 615 | 241, 615 | 2, 685 |
| 1883 | 150 | 1, 278 | 301, 278 | 3, 347 |
| 1884 | 174 | 1, 535 | 349, 535 | 3, 884 |
| 1885 | 267 | 1, 449 | 535, 449 | 5, 949 |
| 1886 | 360 | ........ | 720, 000 | 8, 000 |
| 1887 | 290 | 1, 180 | 581, 180 | 6, 458 |
| 1888 | 375 | 150 | 750, 150 | 8, 335 |
| 1889 | 185 | 1, 505 | 371, 505 | 4, 128 |

# TIN.

# TIN.

## PRESENT POSITION AS AN INDUSTRY.

Tin mining in the United States presents the exceptional condition of an industry giving employment to many persons, but which at the end of the census year had not reached the stage of producing commercial tin. Although the industry has been in this position since 1884, there seems to be no doubt that tin will eventually be produced. The open question which requires actual production to decide is, whether the industry will be profitable and therefore permanent. This question has excited great discussion, for the reason that tin is produced in comparatively few localities, and hence the usual ignorance of its comparatively humble economic position among the metals.

4 states are at present concerned with enterprises for producing tin, as follows: California, South Dakota, Virginia, and Wyoming. The following table shows the amount of work done in each state in this direction:

TIN STATISTICS FOR THE YEAR 1889. (*a*)

| STATES. | Total output of tin-bearing rock. (Short tons.) | Total capital. | Total amount paid for wages. | Other expenditures. |
|---|---|---|---|---|
| California | 5,000 | $650,000 | $18,464 | $12,065 |
| South Dakota | 22,000 | 200,000 | 181,783 | 48,752 |
| Virginia | 1,000 | 48,000 | 1,800 | |

*a* No work done in Wyoming in the census year.

EMPLOYÉS ABOUT TIN MINES IN 1889.

| STATES. | Number of openings. | ABOVE GROUND. | | | | | | BELOW GROUND. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Foremen. | | Mechanics. | | Laborers. | | Foremen. | | Miners. | | Laborers. | |
| | | Number. | Average wages. | Number. | Average wages. | Number. | Average wages. | Number. | Average wages. | Number. | Average wages. | Number. | Average wages. |
| California | 6 | 2 | $4.66 | 34 | $3.30 | 31 | $2.80 | 1 | $6.46 | 9 | $2.81 | 2 | $2.14 |
| South Dakota | 621 | 8 | 4.39 | 28 | 3.25 | 49 | 2.50 | 5 | 3.60 | 132 | 3.00 | 8 | 2.50 |
| Virginia | 40 | 1 | 4.17 | 1 | 1.25 | 11 | 1.00 | | | | | | |
| Wyoming (*a*) | 11 | | | | | | | | | | | | |

*a* No work done in Wyoming in the census year.

This table shows that much substantial development work has been done on these various deposits. In all 6,000 feet of shafts and tunnels have been put in, besides 2,500 feet of open cuts. In the above statement of labor and wages no account is taken for the so-called assessment work done prior to patenting the claims, as this does not afford a very definite employment, except to the few contractors for such work.

With regard to the present facilities for producing tin, it should be said that concentrating works are ready for operations at Glendale, South Dakota, and others have been ordered to be built at Hill City. At the Cash mine, in Virginia, a concentrator is to be built, and at the Temescal mines, in California, a small plant is in actual operation. There is a concentrator at the Etta mine, and the Tin Mountain Mining Company has a Cyclone pulverizer and other mining property.

## OCCURRENCES OF TIN ORE.

Tin in the form of its oxide, cassiterite, occurs disseminated very generally in granitic rocks. Hence traces of it have been noticed in many places in the United States, and it is very probable that it will be observed in many more localities. It occurs, however, very sparingly. It has been noticed in Maine, New Hampshire, Massachusetts, Connecticut, Virginia, North Carolina, Alabama, Texas, South Dakota, Wyoming, Montana, Idaho, Colorado, and California, and Professor W. P. Blake reports that chemists have found traces of it in the magnetic iron ores of the highlands of New Jersey and New York. Reports of tin ore from Missouri and from the head of Lake Superior have been made, but not confirmed. In all these places the general mode of occurrence is similar, that is, in coarse crystalline rocks, granite, gneiss, mica-schist, etc. Many interesting minerals are found associated with the tin ore, among them fluorite, wolfram, copper and arsenical pyrites, apatite, spodumene, columbite, etc., to which reference will be made in connection with the several localities. A good description of these localities was given by Professor W. P. Blake in Mineral Resources of the United States, 1883 and 1884, and which has given much aid in the following résumé:

### NEW ENGLAND STATES.

**Massachusetts.**—Perhaps the earliest mention of tin ore in the United States was made by Professor Edward Hitchcock, who found it at Goshen, Massachusetts, in 1829. He describes it as occurring in a granite bowlder apparently derived from adjacent granite in place. He also found it in Beverly.

**New Hampshire.**—In 1840, Dr. C. T. Jackson discovered tin ore in place in Eastman's hill, at Jackson, New Hampshire. It occurs in small veins 0.5 inch to 8 inches in width in the widest part. The tin ore, which is, as usual, cassiterite, is associated with copper and arsenical pyrites, fluorite, and phosphate of iron. The veins traverse mica slate and granite, in the vicinity of a trap dike. In the middle a streak of quartz subdivides the vein. No tin has been obtained from either of the localities mentioned above.

**Maine.**—A more definite occurrence of cassiterite was noticed in the granite rocks in Maine in 1869, by Dr. C. T. Jackson, in the town of Winslow. It has also been found at Paris, Hebron, Peru, Norway, and Rumford. At Winslow there were at least 12 veins, which, according to Professor C. H. Hitchcock, traverse a very hard and compact siliceous and micaceous schist containing pyrite and near a layer of quartzite. The veins are small, from 0.5 inch to 3 inches in width, but numerous. They are generally interlaminated with the rock, though occasionally cutting across it for a short distance. The vein filling consists of white mica on each wall, then a medial line or mass of fluorite, in which the crystals of cassiterite are irregularly dispersed. Other minerals, such as mispickel and beryl, are found. In 1880, after an examination by Professor Hitchcock, the Maine Tin Mining Company was organized to work these veins. A shaft was sunk to a depth of 100 feet and a crosscut made of 20 feet at the bottom; also 1 at 90 feet from the surface. The veins thus cut appeared to be dipping toward each other; 4 had already merged to 2. A sample of tin from this deposit is on exhibition in the United States National Museum, at Washington.

### SOUTHERN STATES.

**Virginia.**—Stream tin has been found sparingly for many years in the gold-bearing gravels in Virginia, but about 1880 cassiterite was found in place on the eastern edge of Rockbridge county, about 8 miles east of Vesuvius station, on the Shenandoah Valley railroad. It has also been discovered over the county line in Nelson county. Various mining reports have been made on the property and much useful information obtained. It seems that there is an area of 3 by 4 miles of exposed crystalline rocks, in various parts of which veins of tin ore and quartz occur. The principal lode is apparently made up of several parallel veins, all extending in coarse-grained feldspar, mica, and hornblende in the general direction of the rock formations, with various smaller offshoots.

The tin ore is cassiterite, in sheets, strings, and nodular masses through the veins. Sometimes the veins are found an inch wide and very pure; in other places they are more or less replaced by white quartz. The associated minerals are wolframite, mispickel, and beryl. The principal opening has been made on Mount Maria, and is known as the Martha Cash mine. Near this and on an adjacent mountain to the southeast many other openings have been made. Various reports by experts have been made on this property, and as they have been more or less favorable, efforts have frequently been made to develop the deposits. The Virginia Tin Mining and Manufacturing Company was organized in 1884, with Mr. Edgar Whitehead, of Amherst Court House, as president. A shaft or two was sunk, and then litigation delayed the development until 1889, when the Boston Tin Mining Company acquired title from the Cash heirs, and have proceeded more vigorously with development work. A vertical cut of about 100 feet by 150 feet horizontally has been made in the mountain and considerable ore piled up. Hoisting machinery and a Golden Gate concentrator have been received at Vesuvius station, and as soon as a good wagon road is opened to the mine development work will proceed rapidy.

The Nelson county deposits are an extension of those in Rockbridge.

The deposits in the southern part of Amherst county are less known. Lately another deposit has been attracting attention near Berryville, Virginia, but is only in the initial stages of development.

**North Carolina.**—Tin ore was discovered in 1883 in Cleveland county, near Kings mountain. Specimens were exhibited at the mechanics' fair in Boston in 1883. Little is known of the deposit, and only slight efforts have been made at development.

**Georgia.**—Minute quantities of tin ore were found by Professor W. P. Blake in the residues of gold-washing operations in Lumpkin county.

ALABAMA.—Professor C. U. Shepard has found tin ore in Coosa county, and Mr. G. W. Gesner, of New York, has found it in Clay county, near Ashland, at what has been known as the Broad Arrow mine, and some work has been done in developing the property, not, however, within the census year. The formation is described by Mr. Gesner as gneiss, through which the tin ore is disseminated in grains and pebble-like masses over a breadth of 10 to 20 feet. It is associated with white quartz and limonite.

TEXAS.—Professor Theodore B. Comstock, with Professor E. T. Dumble, state geologist of Texas, has lately discovered cassiterite occurring in Llano and Mason counties. Professor Comstock states that as yet no workable deposits have been found, but the indications are such as to encourage prospecting. The cassiterite has all been found in a belt of the lowest archæan rocks, trending north 75° west through Llano and Mason counties, with a short extension eastward across the Colorado river into Burnet county. Very much of the material which has been reported as tin ore from this district is keilhauite, tourmaline, or black garnet, but the cassiterite has been collected by members of the survey from 4 localities besides the one in which an old furnace was discovered with tin globules in the slag dump.

SOUTH DAKOTA.—The fact that tin ore exists in the Black Hills of South Dakota has been known since 1877, when it was definitely established by Mr. R. H. Pierce, of Argo, Colorado. Mr. Pierce found grains of tin stone in some auriferous sand sent him by a prospector. No attention was paid to the discovery until June, 1883, when Major A. J. Simmons, of Rapid City, South Dakota, forwarded a box of specimens to General Gashwiler, of San Francisco, which, on examination by Professor W. P. Blake, proved to be cassiterite in a massive form. The mass yielded on examination 40 per cent of metallic tin. A month later Professor Blake examined the property, took an account to capitalists in New York, and published notices of the discovery in the Engineering and Mining Journal and in the American Journal of Science. The Harney Peak Tin Mining, Milling, and Manufacturing Company was formed, and by its example many claims were soon located in the Black Hills.

CONDITIONS OF OCCURRENCE IN THE BLACK HILLS.—The Black Hills have resulted from the upheaval of a mass of archæan rocks in the flat prairie land. The rocks which form the central portion of this uplift are mica schists and slates. In them great lens-shaped masses of granite are found. It is in this granite that tin ore occurs, either disseminated through the rock or in more characteristic vein-like formations. These veins are sometimes coarse mica and quartz and sometimes quartz alone. When contained in a bed of quartz, large pieces of ore are found, but occurring very irregularly. When contained in coarse granite the ore is more finely and generally disseminated. The general shape of the outburst is roughly an ellipse with a north and south axis, and there are a few outlying patches of schists containing tin-bearing granite. The outburst extends from north of Hill City, in Pennington county, down into Custer county. There is an outside upheaval, smaller but of similar character, in Lawrence county, which furnishes the tin mines of the so-called Nigger Hill district, which has been developed over the line in Wyoming. The rock in Harneys Peak itself has so far been found to be barren of tin, but many claims have been opened in the granite around it. The original mine, the Etta, is on the east side of Harneys Peak. Farther to the north several mines have been opened, and the claims become still more numerous in circling the north side of the peak to Hill City, which is perhaps the center of activity at present. To the southwest another group of mines is reached in Custer county, called the Tin Mountain group, and containing the Glendale group before completing the circle to the Etta mine. The Nigger Hill district is just over the boundary line in Wyoming, and here again much prospecting has been done and many mines have been opened.

The following list, while not complete, will give a fair idea of the various claims in the Black Hills:

LIST OF TIN CLAIMS IN THE BLACK HILLS, SOUTH DAKOTA.

CUSTER COUNTY.

| MINES. | Name of operator. | Post-office address. |
|---|---|---|
| Tin Mountain | Tin Mountain Mining, Milling, and Manufacturing Company. | Chicago, Illinois. |
| Cyclone | H. G. Butterfield & Co | Custer City. |
| Crooked S. | do | Do. |
| Daniel Boone | do | Do. |
| James Wilson | do | Do. |
| McKinney | do | Do. |
| McLaughlin | do | Do. |
| Tempest | Dolphin Tin Mining Company | Do. |
| Amboy | Gaylord & Russell | Do. |
| Minnehaha | do | Do. |
| Oakland | do | Do. |
| Ophir | do | Do. |
| Rob Roy | do | Do. |
| Alta | Charles Harbach | Do. |
| Altoona | do | Do. |
| Alpine | do | Do. |
| Belle | do | Do. |
| Bird | Charles Harbach | Custer City. |
| Covenant | do | Do. |
| Empire | do | Do. |
| Estelline | do | Do. |
| Excelsior | do | Do. |
| Florence | do | Do. |
| Frankie | do | Do. |
| Harney King | do | Do. |
| Henrietta | do | Do. |
| Holiday | do | Do. |
| Kate | do | Do. |
| Link | do | Do. |
| Monroe Rose | do | Do. |
| Pilot | do | Do. |
| Rosetta | do | Do. |
| Tin Key | do | Do. |
| Duck No. 1 | do | Do. |
| Red Bird | do | Do. |

## LIST OF TIN CLAIMS IN THE BLACK HILLS, SOUTH DAKOTA—Continued.

### CUSTER COUNTY—Continued.

| MINES. | Name of operator. | Post-office address. |
|---|---|---|
| Gladstone | Charles Harbach | Custer City. |
| Louise | E. C. Hunt | Do. |
| Saint Joseph | Kleeman & Co | Do. |
| Good Luck | ...do | Do. |
| Halifax | ...do | Do. |
| Saint Joe No. 2 | ...do | Do. |
| Saint Joe No. 3 | ...do | Do. |
| Tin of Plenty | ...do | Do. |
| Lincoln | C. Lincoln & Co | Do. |
| Lincoln No. 1 | ...do | Do. |
| Lincoln No. 2 | ...do | Do. |
| Minnie | McLaughlin & Co | Do. |
| War Eagle | ...do | Do. |
| Boy | William Olds & Co | Do. |
| Eldorado | ...do | Do. |
| Great Western | ...do | Do. |
| Saint Joseph | ...do | Do. |
| Saint Joseph No. 2 | ...do | Do. |
| Gap | ...do | Do. |
| Great Western | ...do | Do. |
| Clyde | ...do | Do. |
| Jack | ...do | Do. |
| Lily | ...do | Do. |
| Toronto | ...do | Do. |
| Haven | Thomas I. Wheeler | Do. |
| Saint Luke | ...do | Do. |
| Buckhorn | Clark, Wood & Co | Do. |
| Idaho | ...do | Do. |
| Wonder Fraction | Medill & Nyswanger | Hermosa. |
| Wonder | ...do | Do. |
| Jay Gould | Wood & Co | Rapid City. |
| General Warren | Forydice & Co | Russellville, Indiana. |
| Wallace | ...do | Do. |
| Woodbine | ...do | Do. |
| Pig Tin | ...do | Do. |

### LAWRENCE COUNTY.

| MINES. | Name of operator. | Post-office address. |
|---|---|---|
| May Queen No. 2 | C. J. Finch | Bear Gulch. |
| Belle | Finch & Gaston | Do. |
| Buckeye | ...do | Do. |
| Harrison | ...do | Do. |
| Washington | Hennessey & Co | Do. |
| Volney | ...do | Do. |
| Giant | ...do | Do. |
| Daisy | Mark Hydliff | Do. |
| Indiana | ...do | Do. |
| Michigan | ...do | Do. |
| Ohio | ...do | Do. |
| Twin Pine | Jensen & Jackson | Do. |
| George | Jensen & St. Johns | Do. |
| Swansea No. 3 | McMakin & Co | Do. |
| Swansea No. 4 | ...do | Do. |
| Swansea No. 5 | ...do | Do. |
| Dakota | C. Miller | Do. |
| Homeward Bound No. 1 | White & Jensen | Do. |
| Homeward Bound No. 2 | ...do | Do. |
| Ophir | ...do | Do. |
| Alice | James Calanan | Des Moines, Iowa. |
| Big Blowout | ...do | Do. |
| Charleston | ...do | Do. |
| Crowdog | ...do | Do. |
| Dakota | ...do | Do. |
| Dolcoath | ...do | Do. |
| Diamond | ...do | Do. |
| Jersey No. 1 | ...do | Do. |
| Jersey No. 2 | ...do | Do. |
| Lulu | ...do | Do. |
| Manchester | ...do | Do. |
| Mary Ann | ...do | Do. |
| Modoc Chief | ...do | Do. |
| New Orleans | ...do | Do. |

### LAWRENCE COUNTY—Continued.

| MINES. | Name of operator. | Post-office address. |
|---|---|---|
| New York | James Calanan | Des Moines, Iowa. |
| Poorman | ...do | Do. |
| Pullman | ...do | Do. |
| Spearfish | ...do | Do. |
| Van | ...do | Do. |
| Wanita | ...do | Do. |
| Aurora | ...do | Do. |
| Blackir | ...do | Do. |
| Capleton | ...do | Do. |
| Jay Gould | ...do | Do. |
| Grubb No. 2 | ...do | Do. |
| Jackson | ...do | Do. |
| London | ...do | Do. |
| Little Hughey | ...do | Do. |
| Mace | ...do | Do. |
| Surprise | ...do | Do. |
| Star No. 1 | ...do | Do. |
| Vanderbilt | ...do | Do. |
| Webfoot | ...do | Do. |
| Yankee Notion | ...do | Do. |
| American Eagle | ...do | Do. |
| Badger | ...do | Do. |
| Blacktail | ...do | Do. |
| Bastinado | ...do | Do. |
| Brooklyn No. 1 | ...do | Do. |
| Brooklyn No. 2 | ...do | Do. |
| Consolidated | ...do | Do. |
| Custer | ...do | Do. |
| Evening Star | ...do | Do. |
| Green | ...do | Do. |
| January | ...do | Do. |
| Morning Star | ...do | Do. |
| Parnell | ...do | Do. |
| Pink | ...do | Do. |
| Sam Landers | ...do | Do. |
| Silver Wave | ...do | Do. |
| Star No. 2 | ...do | Do. |
| Waverly | ...do | Do. |
| West Virginia | ...do | Do. |
| Wrong Horse | ...do | Do. |
| Wyoming | ...do | Do. |
| Young American | ...do | Do. |
| Dakota No. 2 | Nigger Hill Tin Company | Lead City. |
| Dakota No. 3 | ...do | Do. |
| Edith | ...do | Do. |
| Nettie | ...do | Do. |
| Sunrise | ...do | Do. |
| Bellfonder | Rhinehart & Co | Do. |
| Buffalo | ...do | Do. |
| Charley | ...do | Do. |
| Elephant | ...do | Do. |
| Finch | ...do | Do. |
| Miles | ...do | Do. |
| Paid | ...do | Do. |
| Rhinehart | ...do | Do. |
| Rockport | ...do | Do. |
| Total | ...do | Do. |
| Turbine | ...do | Do. |
| Atlantic | American Tin Company | No. 53 Broadway, New York. |
| American | ...do | Do. |
| Bangor | ...do | Do. |
| Bertha | ...do | Do. |
| Black Eagle | ...do | Do. |
| Boston | ...do | Do. |
| Bear | ...do | Do. |
| Brooklyn | ...do | Do. |
| Chester | ...do | Do. |
| Clara | ...do | Do. |
| Columbus | ...do | Do. |
| Commercial | ...do | Do. |
| Congress | ...do | |

## LIST OF TIN CLAIMS IN THE BLACK HILLS, SOUTH DAKOTA—Continued.

### LAWRENCE COUNTY—Continued.

| MINES. | Name of operator. | Post-office address. |
|---|---|---|
| Connection | American Tin Company | No. 53 Broadway New York. |
| Cornwall | do | Do. |
| Del Norte | do | Do. |
| Eureka | do | Do. |
| Foxtail | do | Do. |
| Grace | do | Do. |
| Grand Deposit | do | Do. |
| Gray Eagle | do | Do. |
| July | do | Do. |
| Kingston | do | Do. |
| Mona | do | Do. |
| New York | do | Do. |
| Nigger | do | Do. |
| November | do | Do. |
| Pacific | do | Do. |
| P. D | do | Do. |
| Peck | do | Do. |
| Portland | do | Do. |
| Raddick | do | Do. |
| Rattler | do | Do. |
| Red Bird | do | Do. |
| Robbie | do | Do. |
| Rosa | do | Do. |
| Ross | do | Do. |
| Salva | do | Do. |
| Senate | do | Do. |
| Soho | do | Do. |
| Sonora | do | Do. |
| Sontag | do | Do. |
| Spur | do | Do. |
| Steptoe | do | Do. |
| Stratton | do | Do. |
| Tin | do | Do. |
| Valley View | do | Do. |
| Volta | do | Do. |
| Walter | do | Do. |
| W. J | do | Do. |
| Yankee | do | Do. |
| Yolo | do | Do. |
| Cleveland | Cleveland Tin Company | Do. |
| Chicago | do | Do. |
| Isabelle | do | Do. |
| Montana | do | Do. |
| Swansea No. 1 | do | Do. |
| Swansea No. 2 | do | Do. |
| Uncle Sam | do | Do. |

### PENNINGTON COUNTY.

| MINES. | Name of operator. | Post-office address. |
|---|---|---|
| Peak No. 1 | Judge Prindle | Binghamton, New York. |
| Peak No. 2 | do | Do. |
| Tin Bell | do | Do. |
| Glendale | Glendale Tin Company | Chicago, Illinois. |
| Hermosa | do | Do. |
| Hermosa No. 1 | do | Do. |
| Ponca | do | Do. |
| Ponca No 1 | do | Do. |
| Dakota Bank | do | Do. |
| Garrison | do | Do. |
| Hermosa No. 2 | do | Do. |
| Iron Creek No. 2 | do | Do. |
| President | do | Do. |
| Quincy | do | Do. |
| Alabama | Henry Albien & Co | Custer City. |
| Blue Bird | do | Do. |
| Hyena | do | Do. |
| Knob | do | Do. |
| Occidental | do | Do. |
| Old Frank | do | Do. |
| | | Do. |

### PENNINGTON COUNTY—Continued.

| MINES. | Name of operator. | Post-office address. |
|---|---|---|
| Dolphin | Dolphin Mining Company | Custer City. |
| Tempest | do | Do. |
| Tornado | do | Do. |
| Tin Centre | do | Do. |
| Vermont | do | Do. |
| Boston | Charles Hamilton | Do. |
| Clara Belle | Frank Herbert | Do. |
| Matchless | do | Do. |
| Mineral Hill | do | Do. |
| Tin City | do | Do. |
| Tin Queen | do | Do. |
| Black Diamond | Charles Harbach | Do. |
| Venture | do | Do. |
| Lord Thurlow | do | Do. |
| Wright | William Olds | Do. |
| Alta | Caple & Everly | Etta Mine |
| New York | do | Do. |
| Nora | do | Do. |
| Albite | Everly & Scott and Lewis Everly & Co. | Do |
| Brown Tin | do | Do |
| Glendale | do | Do. |
| Riverton | do | Do. |
| No. 6 | William Franklin & Co | Do. |
| No. 9 | do | Do. |
| No. 10 | do | Do. |
| No. 11 | do | Do. |
| Lolo | do | Do. |
| Lincoln | Mrs. William Franklin & Co | Do. |
| Ramelsberg | do | Do. |
| Robert T | do | Do. |
| Advance | Girard & Co | Do. |
| Dixie | do | Do. |
| Mary Anderson | do | Do. |
| No. 1 | J. F. Reed | Do. |
| No. 2 | do | Do. |
| Tin Bar | do | Do. |
| General Sherman | Swanzey & Smith | Do. |
| Metropolis | do | Do. |
| Protector | do | Do. |
| Spotted Tail | do | Do. |
| Saint Paul | do | Do. |
| Chipman | Swanzey & Co | Do. |
| Hayward | do | Do. |
| Jumbo | do | Do. |
| Park | do | Do. |
| Honduros Fraction | do | Do. |
| Honduros | do | Do. |
| Little Mohawk | do | Do. |
| Union No. 1 | Wheelock & Co | Do. |
| Dauntless No. 1 | do | Do. |
| Dauntless No. 2 | do | Do. |
| Dauntless No. 3 | do | Do. |
| Ideal | do | Do. |
| Olive No. 1 | Wheelock & Everly | Do. |
| Olive | do | Do. |
| Del Norte | Irwin Allum & Co | Hayward City. |
| La Belle | do | Do. |
| Moltke | August Eagle & Co | Do. |
| Scotia | do | Do. |
| Tin King | do | Do. |
| Custer | Henry Huss & Co | Do. |
| Barney | do | Do. |
| Gussie | do | Do. |
| Iron Tin | do | Do. |
| Moody | do | Do. |
| Blair | Robert Ottershanger | Do. |
| Butler | do | Do. |
| Ernest | do | Do. |
| Hermosa Fraction | do | Do. |
| Miller | do | Do. |
| Queen | do | Do. |
| Bismarck | Seirth & Co | Do. |

## LIST OF TIN CLAIMS IN THE BLACK HILLS, SOUTH DAKOTA—Continued.

PENNINGTON COUNTY—Continued.

| MINES. | Name of operator. | Post-office address. |
|---|---|---|
| Chicago | Seirth & Co | Hayward City. |
| Cleveland | do | Do. |
| Sam | do | Do. |
| Silver | do | Do. |
| Standby | M. Thomas | Do. |
| Mountain Lion | Scurlock & Co | Hermosa. |
| Boone | Allen, Cool & Co | Hill City. |
| Imogen | do | Do. |
| Clingstone | Allen & Fish | Do. |
| Burr | George Burr | Do. |
| Augusta | Comingham & Co | Do. |
| Apex | do | Do. |
| Great Eastern No. 1 | Victor Courier | Do. |
| Mountain Side | Demereau & Co | Do. |
| Pioneer | do | Do. |
| Tin Bar | do | Do. |
| Tin Bullion | do | Do. |
| Tin Cup | do | Do. |
| Eclipse | John Good & Co | Do. |
| Long John | do | Do. |
| Monte Christo | do | Do. |
| No. 14 | do | Do. |
| S. & G. | do | Do. |
| Pauline | McBacheron & McCarthy | Do. |
| Yellow Jacket | do | Do. |
| 5th of July | Joseph McClure | Do. |
| Tonson | do | Do. |
| Western Belle | do | Do. |
| Ida | McCulloch & Co | Do. |
| Anchor | do | Do. |
| Dolcoath | do | Do. |
| Dolcode | do | Do. |
| Ellen S | do | Do. |
| Fairview | do | Do. |
| Ole Bull | do | Do. |
| Sea Gull | do | Do. |
| Southern Gem | do | Do. |
| T | do | Do. |
| U. P | do | Do. |
| Buena Vista | Nelson & Co | Do. |
| Emma No. 1 | do | Do. |
| Emma | do | Do. |
| Flora May | do | Do. |
| Good Enough | do | Do. |
| Good Enough No. 2 | do | Do. |
| Good Enough No. 3 | do | Do. |
| Nettie | do | Do. |
| Louisa | John Phelan & Co | Do. |
| Mary | do | Do. |
| Nellie | do | Do. |
| Sullivan | do | Do. |
| May Queen | do | Do. |
| Buck | Neil Shoemaker | Do. |
| Buck No. 2 | do | Do. |
| Buck No. 3 | do | Do. |
| Dandy No. 1 | do | Do. |
| Dandy No. 2 | do | Do. |
| Nemo | do | Do. |
| Oh My | do | Do |
| Red Star | do | Do. |
| Sunshine | do | Do. |
| Tin Queen | do | Do. |
| Bismarck | Pat. Smith & Co | Do. |
| Kiote | do | Do. |
| Surprise | do | Do. |
| Bullwacker | C. von Wohrman & Co | Do. |
| Canbready | do | Do. |
| Eagle Bird | do | Do. |
| Fly Speck | do | Do. |
| Gertie Extension | do | Do. |
| Grand Prize | do | Do. |

PENNINGTON COUNTY—Continued.

| MINES. | Name of operator. | Post-office address. |
|---|---|---|
| Idaho | C. von Wohrman & Co | Hill City. |
| Snowshoe | do | Do. |
| Tin Stock | do | Do. |
| Trojan | do | Do. |
| Tin Whistle | do | Do. |
| Wild Dutchman | do | Do. |
| Yellow Jacket | do | Do. |
| Standby | W. L. Pike & Co | Longmont. |
| Monarch | The Peerless Mica and Mining Company. | Madison, Wisconsin. |
| Monitor | do | Do. |
| Protector | do | Do. |
| Newton | L. L. Davis | Rapid City. |
| Good Luck | Everly & Price | Do. |
| American | Francis & Co | Do. |
| Buckeye | do | Do. |
| Etna | do | Do. |
| Eureka | do | Do. |
| Excelsior | do | Do. |
| Pearl | do | Do. |
| Portland | do | Do. |
| Vulture | do | Do. |
| Yankee Boy | do | Do. |
| Jack Rabbit | James Haft | Do. |
| Blue Tin No. 2 | Harney City Tin Company | Do. |
| Blue Tin | do | Do. |
| Everly | do | Do. |
| Margaret | do | Do. |
| Tin Hill | do | Do. |
| Rose Tin | Jacoby & Everly | Do. |
| First Find | Samuel Scott | Do. |
| General Grant | do | Do. |
| Lulu | do | Do. |
| Empire City | do | Do. |
| General Harney | do | Do. |
| Lucky Boy | do | Do. |
| Ocean Queen | do | Do. |
| Brown King | Samuel Scott & Co | Do. |
| Deacon Wright | do | Do. |
| Jonathan | do | Do. |
| Naiad Queen | do | Do. |
| Gentle Minnie | Scott & Wood | Do. |
| Grubstake | Sweeney & Co | Do. |
| Ole Bull | do | Do. |
| White Elephant | do | Do. |
| Calhoun | J. B. Taylor & Co | Do. |
| Darwin | do | Do. |
| Haines | do | Do. |
| Jackson | do | Do. |
| Little Joker | do | Do. |
| Bell Boy | Taylor & McClure | Do. |
| Choctaw | do | Do. |
| Custer | do | Do. |
| Geitaw | do | Do. |
| Lilly | do | Do. |
| Lilly No. 1 | do | Do. |
| Lilly No. 2 | do | Do. |
| Top Sheaf | do | Do. |
| Wilson | T. Wilson | Saint Paul, Minnesota. |
| Wilson Lode | do | Do. |
| Jolly No. 2 | Stephens Tin Company | Scranton, Pennsylvania. |
| Jolly No. 3 | do | Do. |
| Snowbird | do | Do. |
| Bird | do | Do. |
| Crow | do | Do. |
| Eddy No. 1 | do | Do. |
| Eddy No. 2 | do | Do. |
| Jolly No. 1 | do | Do. |
| Little Giant | do | Do. |
| Peacock | do | Do. |
| Sunrise | do | Do. |

### LIST OF LODES OWNED BY THE HARNEY PEAK TIN MINING, MILLING, AND MANUFACTURING COMPANY IN SOUTH DAKOTA.

Addie.
Ajax.
Arab.
Badger.
Ben Butler.
Ben Skinner.
Birdie.
Bismarck.
Black Bird.
Blowout.
Bob Griffith.
Bob Ingersoll.
Broken Link.
Broken Link No. 1.
Broken Link No. 2.
Brown King.
Buckeye.
Butterfly.
Campaign No. 1.
Campaign No. 2.
Campaign No. 3.
Campaign No. 4.
Campaign No. 5.
Cassiterite.
Champion.
Coates No. 1.
Coates No. 2.
Coates No. 3.
Coates No. 4.
Coates No. 5.
Colossal.
Consort.
Cooper.
Cow Boy.
Cow Boy Fraction.
Cow Boy No. 1.
Crow.
Custer.
Czar.
Czar No. 1.
Dapple Grey.
Darwin.
Deacon Wright.
Delaware.
Delia.
Dolphin.
Doubtful.
Duplex.
Edna.
E. Fish.
Elgin.
Endless Chain.
Etta.
Evaline.
Excelsior.
Extension.
Ferguson.
Fifth of July
Florida.
Galena.
Georgia.
Gertie.
Great Eastern.
Greeley.
Grizzly.
Gulch.
G. W. Coates.
Hazelnut.
Helen M.
Hepburn.
Hidden Treasure.
Highland.
Highland No. 1.
Highland No. 2.
Highland No. 3.
Hilda.
Hilda No. 2.
Hortense.
Ida.
Idaho Fraction.
Iron Rod.
Jay Bird.
Jennie.
Jim Fisk.
Julia E.
Junction.
Keystone.
Kit Carson.
Last Chance.
Legal Tender.
Le Grand.
Lizzie.
London.
Madison.
Maggie.
Magnolia.
Mattine.
Merrimac.
Mewonitoc.
Missing Link.
Mohawk.
Moores.
Mugwump.
Naiad Queen.
Nellie.
Never Sweat.
Newton.
No Name No. 1.
No Name No. 2.
Norfolk.
Nutmeg.
Ohio.
Old Jeff.
Peanut.
Pelican.
Pine City.
Ramshorn.
Rover.
Rumby.
Runyon.
Sam.
San Jacinto.
Sarah.
Shorty No. 1.
Shorty No. 2.
Spaniard.
Stannum.
Susan S.
Telegraph No. 1.
Telegraph No. 2.
Tempest.
Thompson.
Tidal Wave.
Tinker.
Tin King.
Tin King No. 1.
Tin King No. 2.
Tin Reef.
Tornado.
Tradesmens.
Transfer.
True Centre.
True Centre No. 2.
True Centre No. 3.
Venus.
Vermont.
Waterbury.
Western Belle No. 1.
Western Belle No. 2.
What Is It.
White Eagle.
White Whale No. 1.
White Whale No. 2.
Wide World.
Wilson.

Percentage of tin.—Although much work has been done in the Black Hills and countless assays have been made, the tin occurs irregularly and the veins are so changeable that very little is known as to what can be expected when the mines are worked. The best evidence which exists is the record of a trial of 40 tons of rock assayed in England; but this is only a fairly large sample which may be better or worse than the average for commercial operations, in which careful selection of the ore would be made. There is little doubt that the test was perfectly fair as far as it went. The prospective English investors in the property sent Mr. M. C. Vincent to the mines, and in connection with his report he shipped to England about 40 tons of rock from the following group of mines: Addie, Campaign, Coates, Cowboy, Custer, Czar, Darwin, Etta, Excelsior, Gertie, Mewonitoc, Missing Link, Mohawk, Sarah, and Tin Reef. From this, 10 tons were taken and crushed by Messrs. Johnson & Mathey, of Hatton Garden, London. From the crushed ore samples were taken by Mr. Frederic Claudet, assayer of the Bank of England, and Mr. Stephen Davis, of Dolcoath, representing the newspaper critics, and a third sample was drawn by Messrs. Johnson, Mathey & Co. The assays were quite uniform and showed that 10 tons would yield from 2.80 to 2.94 per cent of metallic tin of good quality. By ordinary concentrating methods, such as would be adopted in mill practice, 2.60 per cent of metallic tin was obtained.

In January, 1886, Judge Daniel McLaughlin shipped to London 13,000 pounds of ore from the dumps of Mr. James Callanan in the Nigger Hill or Bear Gulch district. In London this was separated into a number of lots and assayed by several dealers. Messrs. Thomas Bolitho & Sons, of Penzance, found 4.6 per cent of metallic tin, Messrs. R. R. Michel & Co. found about the same, and Messrs. Johnson, Mathey & Co. found in a similar specimen 3.6 per cent of metallic tin.

Development work.—The discovery by Major Simmons that the Etta mine, which he worked for mica, contained tin ore led to its examination by Professor W. P. Blake and the formation of a company in New York to develop it. This was carried out in 1884 on quite an extensive scale under the management of Mr. Gilbert E. Bailey, who had previously been territorial geologist. A mill was erected for concentrating the ore, and in 1885 a trial run of 400 tons of ore was made with the following results: black tin concentrates were obtained which yielded 7 tons of metallic tin, and Professor Frank G. Carpenter found appreciable amounts of cassiterite in the tailings, or waste from the mill. After this the mill and the development of the mine were abruptly stopped, and the attention of the company turned to bonding and purchasing the many prospects found in all directions. The mill run attracted wide attention. Most extravagant statements were made as to the richness of the tin ores to be found, and these, as is usually the case, called forth equally wild and untrustworthy denunciations against the entire tin resources of the Black Hills. It has been asserted by most reputable mining engineers that the mines usually contained nothing but worthless columbite, and that in no case would mining pay if the tin were as valuable as silver. But nevertheless the search for tin prospects has gone on energetically from 1884 to the present, the principal impetus being the comparative ease with which a customer could be found in the Harney Peak Company. This, however, was not the only enterprise which has gone further than prospecting. In the neighborhood of the Custer group of mines the Tin Mountain Mining Company has erected a concentrator with a Cyclone pulverizer in the hope that this might prove more efficient in dealing with the micaceous gangue. This plant is still in readiness for work, but nothing was done with it in the census year. In the Glendale region, already referred to, a very complete concentrating plant stands nearly finished. It is connected with the mines by an efficient system of wire-rope conveyors. In the Nigger Hill district the Cleveland Tin Mining Company has made an independent effort to the extent of putting the mines in condition for shipping, and is waiting for reduction works. The same is true of the Stevens Tin Mining Company. At present the attitude of all these independent concerns seems to be that of waiting for further developments by the pioneer company, when purchasers can be found or custom concentrators and reduction works can easily be obtained. Attention is entirely directed to the development work of the Harney Peak Tin Mining, Milling, and Manufacturing Company. In 1888 this company extended its nominal capital of $10,000,000 to $15,000,000. This was done in London after first withdrawing the enterprise on account of energetic attacks by some English papers. After the visit of English mining men to the mines, however, the capitalization was extended. This very great and, as in many such mining enterprises, entirely presumptive valuation was made upon the data already given, showing by fair tests that 40 tons of ore had been collected from various groups of mines, yielding 2.94 per cent of metallic tin. From that time to the present prospecting and development of the more promising openings have gone on. Hoisting plants have been erected at many openings, and underground developments have proceeded as indicated in the statistics already given. In 1889 attention was given to the selection of a site for a concentrating plant. The care in this selection of a site and in the method of treating the ores was manifestly necessary since the conditions include producing tin with very great cost for labor compared with all competitors, and the lesson of the Etta mill shows that ore can easily be lost in the tailings. The developments should go forward with much greater rapidity hereafter because the Burlington and Missouri River railroad has been opened through Custer and Hill City to Deadwood, and the introduction of heavy machinery is no longer so expensive. In July, 1891, Hill City was selected as the site for the concentrator. The contract for its erection was at once given, and the work has been commenced.

California.—Deposits of tin ore have long been known in San Bernardino county, about 60 miles east of Los Angeles. The region is commonly referred to by various names, as Temescal, from the mountains on the northeast and the creek on the southeast, or as San Jacinto, the name of the ranch in Mexican times on which the deposits occur, and as Cajalco, the name of the principal opening. The tin lodes are found in a formation of granite, extending for several miles northwest and southeast. A dark-colored porphyry rises 700 feet on the east of Temescal creek. After crossing about 2 miles of this it changes in color to gray, and then the granite is reached, which gives place to light-colored porphyry about 5 miles farther east. In this granite a succession of lodes of all widths up to 12 feet are met, generally at right angles with the trend of the granite and dipping to the northwest 60° from the horizontal. More than 60 of these veins have been located and their courses determined. These veins or lodes are made up of quartz, chlorite, oxide of iron, and cassiterite. The oxide of iron gives a peculiar appearance to the tin ore different from that found elsewhere. The property is still in the form of the San Jacinto estate, an irregular tract of about 15 square miles, about 3 miles wide by 5, in the direction of the granite strip. The town of South Riverside adjoins it on the north. In 1846 this property was received as a grant by some Mexicans from the Mexican government. Many years afterward it became the field of a considerable gold-mining excitement, and this prospecting developed the tin lodes. After this the San Jacinto Tin Company bought the titles of the Mexican grantees and have been perfecting the titles since then.

The Supreme Court of the United States has finally confirmed their title, and, litigation ended, the property came on the market for extension of capital and the proper exploitation of the lodes. So far, this consists principally in the work done on the Cajalco lode, which showed heavy outcroppings of tin ore. An adit was run in for a short distance on the lode on the south side of a small ravine at a level about 70 feet from the highest outcroppings. On the north side of the ravine the adit has been run in over 400 feet and an incline shaft sunk on the vein intersecting and ventilating the adit tunnel. The shaft also connects with a lower level under the main adit. The tunnel shows 6 feet of tin-bearing ore in many places. There are in addition many prospect holes and ditches on the other claims. It is proposed to develop the lodes by a long adit tunnel to the creek, where concentrating and reduction works are to be located.

In 1890, by the vigorous work of Mr. E. N. Robinson and others, the concentrating of the tin ore was begun, and up to May 23, 1891, about 12 tons of pig tin had been reduced. A telegram from the company on that date stated that they were producing 1,000 pounds of pig tin daily with a 5-stamp mill, and expected to increase this plant to 60 stamps in 90 days.

All the analyses which have been published show a very favorable percentage of tin in the rock, although the working assays from the recent mining have not yet become accessible; but the increased activity at the mine in 1891, with more than 100 employés, shows the owners' confidence in the enterprise.

## FOREIGN PRODUCTION OF TIN.

**World's supply.**—The amount of tin demanded for the world's consumption is annually about 53,000 short tons, about one-sixth as much as the copper or one-eighth of the zinc or one-tenth of the lead consumption of the world. Many countries have contributed to this supply, among them the Straits Settlements of Malacca, including the islands of Banca and Billiton, Queensland, New South Wales, Victoria, Tasmania, India, Burmah, Japan, China, Cornwall in England, France, Germany, Austria, Italy, Spain, Portugal, Russia, Sweden, and South America. Cassiterite has been found in several other localities, especially in Durango, New Mexico, and at Wicklow, Ireland. The present supply, however, comes from the Straits Settlements, Banca and Billiton, Australia, and Cornwall, as shown below:

WORLD'S SUPPLY OF TIN FOR 10 YEARS.

[Tons.]

| ITEMS. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. | 1886. | 1887. | 1888. | 1889. |
|---|---|---|---|---|---|---|---|---|---|---|
| Total | 38, 321 | 39, 403 | 39, 671 | 45, 746 | 44, 252 | 43, 699 | 45, 557 | 50, 371 | 50, 721 | 52, 978 |
| English production | 8, 918 | 8, 615 | 9, 300 | 9, 307 | 9, 574 | 9, 331 | 9, 312 | 9, 282 | 9, 241 | 8, 912 |
| Straits shipments to Europe and America | 11, 735 | 11, 400 | 11, 705 | 16, 958 | 17, 548 | 17, 320 | 19, 674 | 23, 977 | 23, 855 | 28, 295 |
| Australian shipments to Europe and America. | 9, 177 | 10, 100 | 10, 067 | 11, 121 | 9, 337 | 9, 088 | 8, 064 | 7, 750 | 7, 975 | 6, 800 |
| Banca sales in Holland | 3, 756 | 4, 548 | 4, 399 | 4, 203 | 4, 193 | 4, 200 | 4, 379 | 4, 384 | 4, 430 | 4, 114 |
| Billiton sales in Java | 4, 735 | 4, 740 | 4, 200 | 4, 157 | 3, 600 | 3, 760 | 4, 128 | 4, 978 | 5, 220 | 4, 857 |

The greatest producing region at present is in the British Straits Settlements, on the Malayan peninsula. The axis of this peninsula is a granite ridge averaging about 3,000 feet in height, which seems to contain cassiterite generally distributed through it. Although the rivers are very short, great alluvial deposits rich in tin ore have been formed from the disintegration of this granite. These alluvial deposits are the chief source of the tin at present, and the great yield, aggregating half the product of the world, is due to the cheap mining possible in such placer beds. The same conditions hold in the adjoining Dutch East Indies, where the islands of Banca and Billiton furnish over 10,000 tons each year.

The literature concerning the mode of occurrence of tin, the mining methods, rates of wages, etc., in the East Indies is very scanty and makes particularly valuable the excellent description of the alluvial tin deposits of Siak, Sumatra, which Mr. Charles W. Rolker, E. M., has lately published in the Transactions of the American Institute of Mining Engineers, and which is condensed below:

Tin was discovered in Banca as early as 1710, and has been produced there ever since; but the supply has been most important since Banca came fully into the possession of Holland, in 1821. In Billiton and the adjoining island of Sing Rep, the existence of tin was known prior to 1822. (*a*) The Lingganese knew of its existence in the valley of Embalong, from creeks and streams in the neighborhood of Tima and Simper hills, on Billiton and also on Sing Rep island, but the prevailing superstition that tin mining brought misfortune influenced them to let this industry lie idle. The attempts of the Dutch government to test this question were lukewarm, perhaps by reason of the fear of reducing, through new discoveries, the price of Banca tin, and the island was abandoned in 1826, leaving only a military post. In 1850, Dr. Crookewit, a chemist and naturalist, was sent out to verify the rumors that tin existed in Billiton. His report was unfavorable; but in 1851 Mr. C. De Groot, a mining engineer, found tin readily, and the active work on Billiton dates from that time. Less than 500 tons were produced during the first 10 years, and 3,000 tons in the next decade. Billiton tin mining is done by private parties, while 70 per cent of the mines of Banca are controlled by the Dutch government. Formerly that government controlled all the Banca mines. The Banca metal is shipped to the island of Java and exported from the port of Batavia to Holland. It figures in the markets as tin exported from Batavia.

In the Malay peninsula the Chinese are known to have worked tin diggings as early as 1793. Since then the development has been gradual until a comparatively recent date. In 1866 the exports of tin metal (white metal) amounted to 5,692 tons; in 1874 the total was 13,566 tons; in 1883 it was 17,195, and rose to 28,492 tons in 1889, an increase of 65 per cent. This shows the extensive development of tin mining in these parts of the world. The energy displayed is great in view of the natural conditions of the country and the disadvantages under which work is prosecuted.

New tin fields will unquestionably be found in the peninsula, as well as within that belt of countries or islands which lies between Australia on the south and the Malay peninsula on the north, known as the Sunda, and their adjacent islands, but so far no considerable production can be traced from any of the latter districts outside of Banca and Billiton. Prospecting and developing the islands referred to will be slow and difficult, because of their dense tropical vegetation, unfavorable climate for labor, and a lack of facilities for such enterprises.

The tin deposits of Banca and Billiton, the types of the Indian archipelago, are mainly alluvial, although some lodes, supposed to be of recent origin, have been worked. According to Davies, the bed rock of the country is granite, metamorphosed slates, quartzites, and sandstones. A cross section through the Banca deposits would show, following from bed rock upward, an average of 3 feet of tin ore overlaid with coarse sand, followed by clay (red, white, and black), then coarse sand, with pockets of clay and layers of fine sand carrying a little tin ore, and then humus. The average overburden is 25 to 35 feet thick. Similar conditions are said to exist on the Sing Rep, Carimon, and other islands, where so far only desultory prospecting has been done, without financial success, or where companies have only lately been organized for work. Tin has been found as far east as the island of Floris, in the Floris sea. The tin of Banca and Billiton has been traced to its original sources in the granite and gneiss; it is also found cutting through the supposed

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[a] Dr. Th. Pozewitz, Peterman's Geographische Mittheilungen, 1887.

overlying quartz schist, clay slates, and clayey sandstones, but, so far as can be learned, very little lode mining has been profitably done. In the Malay peninsula tin lodes have been found, in addition to alluvial tin, and preparations are in progress to test their value.

The attention of capital was lately directed to a tin field on the island of Sumatra and within the district of Siak. It lies inside a large tract of land, estimated by the promotors to contain 400,000 to 500,000 acres, conceded by the sultan of Siak, Iri Indrapoera, in 1887 to Dutch parties "for the extraction of tin and other minerals which appear in that part of the dominions". The official limits of this concession are quoted to define the geographical position of what is considered the tin belt of East Sumatra. The ground conceded by the sultan is bounded "on the north by the part of an imaginary line running from Loeboehbandahara, on the Rohkan river, as far as Tandjong Maris to the Tapong Kanau river (in Siak), and further by the Tapong Kanau river; on the east by an imaginary straight line drawn from the southern boundary of Siak, straight from south to north, and running through Batoegadja as far as the Tapong Kanau; on the south by the independent states to Kampang Kanau and the Podang highlands, and on the west by the Rohkan states". These are the official boundaries of the tin fields, based on the knowledge of the government. Since all inhabitants working the tin deposits are obliged to pay a tax to the sultan on the tin produced, it is to be assumed that the government had a guide in thus delineating the confines of the prospective tin fields, in addition to its knowledge of the work of an exploring party in 1881.

Sumatra is divided longitudinally, by volcanic ranges, into the east and west coast country. The west coast is a narrow strip of land, 20 to 30 miles wide, underlaid, according to Dutch geologists, with granite; in places it is covered with alluvium and coral formation, sandstones, slates, and volcanic rocks. Marble and coal are found near Podang, and the precious metals are mined in other parts. Several railroads extend from the coast to the foot of the mountains above mentioned. East Sumatra is a generally low and slightly undulating country, of the geology of which little is known. Marshy districts abound in consequence of the extensive flood plains of the large rivers. The rivers rise in the divisional range and flow in a tortuous course to tide water, but as they approach it the big streams grow sluggish and form more or less distinct deltas. The main rivers, taken in order from north to south, are the Rohkan, the Siak, the Kampar, the Indragiri, the Jambi, and the Pelambang. The last is said to be navigable for more than 200 miles for large vessels. Each river system has numerous tributaries.

The climate of east Sumatra is warm and moist. Rains abound from October to March. The remainder of the year, although spoken of as "the dry season", is far from arid. Thus at Kotta Ranah, lying inland in the Siak district, there were from the 15th of June to the 1st of July 3 rainy days, on which the rainfall amounted to 71 millimeters. During July it rained on 17 days, the total rainfall amounting to 289 millimeters; in August rain fell on 21 days, to the amount of 282 millimeters; and during the first 7 days of September rain fell on 6 days, to the amount of 98 millimeters; that is to say, out of a total of 84 days in the height of the "dry season" it rained on 47 days a total of 740 millimeters, or an average of 15.4 millimeters for each rainy day.

On an average it rained nearly every other day at Hilversum in Siak, with an average rainfall of over 18 millimeters per day. This is a better showing than that of Kotta Ranah, further inland, as given above, but the average would be greater if January and February had been recorded.

As a result of rains and the level character of the wide eastern country, flooding of the districts traversed by the main streams and their tributaries is a frequent occurrence, and marshy land abounds. This is especially the case along the Siak river and south of it.

The tin fields of Sumatra are approached by steamers of 12 feet draught running from Singapore across the straits of Malacca to Brewer straits, up the Siak river to Benkalis, thence south to Siak and east to Packanbaroe. The distance up the river to Packanbaroe is, according to the captain of one of the steamers, 120 miles. Beyond Packanbaroe the Siak river becomes very sinuous, is obstructed by fallen trees and logs, and, still further up, grows shallow. In consequence all traveling from Packanbaroe upstream is done in bloncongs, or partially covered canoes of a similar type to that used on some streams of South America (Magdalena river, etc.). The bloncongs are propelled by poling or rowing, as the case may require. From Packanbaroe the Siak winds in an easterly direction to Getti, which lies about 20 miles along the river beyond Batoe Gadja, the place mentioned in the description of the boundary of the concession as the one through which the north and south line runs. There may be counted 176 curves or bends of the stream between Kwalla and Batoe Gadja. Kwalla, at the junction of the Tapong Kanau (right arm) and Tapong Kiri (left arm), forming the Siak river, lies about 20 to 22 miles upstream from Packanbaroe. This gives more than 2 curves for every mile along the river. Many of these bends are rectangular turns, and quite a number of loops and return loops are met, which make navigation impossible for any but small craft. The cost of transportation, part by steamboat, part by canoe, entailing the breaking of bulk, the use of storehouses, etc., is naturally a heavy charge against any enterprise commenced in this district. Whoever is acquainted with tropical streams, subject to floods and incidental dangers from drift timbers, etc., will view the making of this river navigable as a difficult and costly undertaking, especially if it is considered that the waters of the stream (more than 100 feet wide) rose at Batoe Gadja in the "dry season", between July 18 and September 13, 1890, more than 18 feet; yet this was an ordinary season. The substitution of land transportation for the natural water ways would encounter special difficulties, arising from the marshy condition of that part of east Sumatra.

Any enterprise undertaken near the interior of Sumatra is for the present confronted with inherent obstacles and disadvantages, involving heavy initial costs which can be offset only by extraordinary richness of the natural resources to be developed.

The present center of operation in this tin field is Kotta Ranah, lying about 300 feet above the sea, in longitude 100° 43′ east, latitude 0° 26′ north, and connected by a trail, not more than 15 miles long, with the Siak river station Getti. Over this trail all freight is carried on the backs of the native Malays. The trail is bad. Probably one-third of it passes through marshes and swamps, over fallen trees and logs, where leeches, the pest of these regions, abound. The second third passes over low, flat lands, and the remainder over rolling hills. Transportation over this distance cost formerly $1, Mexican money (*a*), per load of 40 pounds; it has now been reduced to 66 cents per load. Bloncong hire from Packanbaroe to Getti for shipment of supplies costs $30 to $35 per bloncong for the round trip, but if steadily employed bloncongs can be rented for $55 (Mexican money) per month. Communication is naturally slow. The average time occupied by a bloncong in a round trip, from the steamer discharge pier in Packanbaroe to Getti and Kotta Ranah and back, is 15 days. Temporary heavy floods or very low water may increase the time required. As much as 22 days has been consumed in the trip. The drawbacks and inaccessibility of this region have been emphasized in order to contrast it with the naturally advantageous situation of Banca, Billiton, and other tin-producing competitors.

Kotta Ranah lies about 6 miles northeast of Bukit Siligi, the 3 high peaks in the most easterly chain of the divisional ranges. The axis of this range runs northwest and southeast, and mountain spurs extend from it to the northeast out into the lowlands. These spurs form local watersheds to the tributaries and subtributaries of the Siak and other rivers. Kotta Ranah is a native hamlet (kampong) situated on the stream (sungi) of Lau. The Sungi Lau unites beyond Kampong Kebon with the Pelambayan, forming the Talanca, a tributary to the Tapong Kiri (the left arm of the Siak river.) It may here be noted that the Malay names the banks of a river as he faces them in going upstream, and calls that the left bank or left arm which in this country would be called the right.

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[a] The peso, or Mexican dollar, is current in Sumatra and Singapore as the trade-dollar of the country.

The nearest kampong to Kotta Ranah is Rambei, on the Sungi Rambei. It lies about 2 miles in an air line northwest from Kotta Ranah. The two hamlets are separated by the foothills of a narrow side spur, divide, or rib, which forces the Rambei stream northeasterly to its junction with the Getti river. The latter has its confluence with the Tapong Kiri (left arm of Siak river) at or about the settlement of Getti. The Rambei and Lau are two distinct stream systems, but both are subtributaries to the Tapong Kiri. The two systems traverse a considerable area, when it is considered that the streams extend yet for miles beyond Kotta Ranah and Rambei, and that the distance from Kotta Ranah to Batoe Gadja, via Kebon and Pelambayan, is nearly 19 miles by measurement; from Kotta Ranah to Getti, estimated, say, 14 miles, while Getti and Batoe Gadja are probably only 10 to 12 miles apart in a straight line. Any kind of material entering the creeks or bycreeks of these streams is likely to be carried through the territory and eventually into Siak river.

The Lau-Rambei system of streams with its tributary creeks forms the basis for the tin operations of the concession above described. A careful examination of the only natural exposures of rock, namely, those occurring in the water channels, and local tests made by borings and pits, leads to the conclusion that the tract under consideration is everywhere underlaid with impure sandstones and quartzites. The partially decomposed red and yellow sandstones near Kampong Kotta Ranah become reddish-gray, and grow micaceous and siliceous as they are traced in the direction of the headwaters of the Sungi Lau toward Bukit Siligi. In the lowlands of Kotta Ranah the dip is generally very slight to the southeast. As the hills are entered the dip increases, and locally along the upper Lau the sandstones are tilted vertically, though flattening again beyond. This hard, fine-grained, gray cascade sandstone consists, according to microscopic examination, of rolled grains of quartz, with abundant amphibole and biotite, scales of white hydro-mica, particles of kaolinized feldspar and iron ocher. The headwaters of the Sungi Blevon (Rambei district) come, to judge by appearances and their mode of occurrence, from a fine-grained reddish or greenish quartzite.

Near and west of the headwaters of the Sungi Batang (Kotta Ranah district), and for 1,500 to 1,700 feet along its banks in the ravine, bowlders, blocks, and pieces of a black compact quartzite, somewhat resembling the whimstone of Cornwall, were found, indicating its occurrence in situ on the adjacent hill. The two quartzites differ in appearance, but under the microscope they seem to show similar origin and constituents. In fact, the transitions to the siliceous and micaceous standstone, so well marked to the eye, nearly disappear under the microscope. Even the ordinary red, yellow, and yellowish-green impure sandstones show similar constituents, only in differing proportions and varying stages of decomposition. As a check to the microscopic examinations of finely pulverized rock-samples, different characteristic samples were submitted to Dr. A. Julien, of the Columbia School of Mines, for thin section examination. What is termed quartzites Dr. Julien calls "sandstones, quartzitic in hardness and compactness". All the rocks are unquestionably of sedimentary origin. The quartzite of Sungi Blevon is composed of rolled grains of quartz, with an abundance of amphibole, a little biotite, and mennacanite. The quartzite of Sungi Batang has the same constituents, only amphibole occurs in very small proportions, and a small quantity of pyrite is present.

The yellow and red sandstone represents results of decomposition. The more or less rounded grains of quartz, which predominate, are cemented by iron ocher, in association with a fine mixture of decomposed scales of hydro-mica and particles of biotite, amphibole, feldspar, and mennacanite. Besides the sedimentary rocks mentioned, there is a place near the red sandstone exposure, east of Kampong Kotta Ranah, where granite has been laid bare by the last right-hand tributary of the Sungi Kalomboi for a distance of 60 to 75 feet. This granite shows, in a quartzose and albitic matrix, white muscovite and black tourmaline. Within the area exposed is a lode about 6 feet wide, of a very fine-grained granite, contrasting with the coarse inclosing granite, from which it is separated in addition by a smooth plane. It appears like a product of segregation. The composition of the two granites seems similar, but the proportion of quartz is larger in the lode. Bedding-planes are observed, suggesting what Dr. Hunt calls an indigenous granite.

The Kalomboi streams show more or less abundant traces of this rock up to the next tributary on the right, suggesting a similar exposure in the next ravine. No tin could be found in this granite. South of this and along the west banks of the Kalomboi the yellow sandstones are observable. Fragments of a similar granite were found in the Blevon and Katjang creek beds, which would indicate that a granite exists north of the Lau-Rambei divide, though diligent search failed to find it in place.

The density of vegetation makes prospecting difficult. Almost every line explored has to be previously cleared by bushmen. In view also of the limited time at the disposal of a transient explorer, the interruptions and delays caused by frequent drenching from tropical rains, and the dissuasion (from too minute examination of the jungle) furnished by occasional tiger tracks, it will be clear that a thorough study of the geology of the region was not practicable. Such a study will require long and systematic work. Briefly summarized, the red sandstones crop out southeast of the Sungi Pingir and Lau confluence, and again west of Kampong Rambei, toward the Bleoon-Rambei confluence, and south from Kampong Rambei toward Sungi Quay. All sandstone exposures found (beyond those enumerated) were a yellow sandstone, more or less decomposed by weathering, save along the upper Lau, where the indurated, reddish-gray, micaceous, and siliceous sandstones occur. It is possible that the albitic granite more generally underlies the sandstone beds of this district than is proved by the data now at hand; but it is certain that granite does not come to the surface, for no mica is found in the beds of the mountain streams.

The country north of Kotta Ranah, toward Getti, is slightly rolling for about 6 miles, the remaining 8 miles being half lowlands, half marshes and swamps. The highest altitude, according to corrected readings from a compensated aneroid, is 560 feet above the sea, and the lowest hilltop is 300 feet high, while the lowlands range from 200 feet above the sea level down to 115 feet (at Getti). The underlying formation of this north country, so far as can be judged from the color and nature of the soil on the paths, is sandstone. At and east of Getti an indurated calcareous clay, full of cypridenas and other small shells, forms the shores of the Tapong Kiri. At Batoe Gadja, about 20 feet lower, the banks and the bed of the river are indurated fine clay conglomerate. The clay matrix surrounds rounded quartz granules, from the size of a pin head to pea size, and more angular and partly kaolinized pieces of feldspar. Throughout the mass occur carbonized vegetable remains, and an imperfect impression of a shell was noticed. East of Petapahan, along the lower Tapong Kiri, sandstones occur of more recent formation than the (probably tertiary) Kotta Ranah series. Inland, up and down the Siak river and west of the town of Siak, the soil is very clayey, so much so, in fact, that tobacco growing has been abandoned on account of it.

A comparison of the foregoing account of Sumatra with what is known of adjacent countries shows that similar geological conditions have prevailed in the Malay peninsula, Karimon islands, western Borneo, Singkep, Banca, and Billiton, and as the search is extended this belt of a former geological unity will unquestionably be widened. Quartzites, quartz conglomerates, quartz schists, hornblende schists, siliceous sandstones, clay slates, with granite and local basalts (Karimon islands, according to Natuurkimdig Tijdschrift von Nederlandisch-Indie, volume XLIV), form the prevailing rock formations.

In examining the Kotta Ranah-Rambei stream system and banks for alluvial tin, a universally shallow and similar alluvial covering was found. The covering over the angular quartz gravel averages 3.5 to 4 feet, and consists of about 6 inches of humus and 3 to 4 feet of yellow sandy clay. The underlying angular quartz gravel is itself divided into 2 separate layers. The upper, 8 to 10 inches, consists of angular fragments of white quartz, of 3 inches maximum and 1 to 1.5 inches average diameter, largely intermixed with carbonized wood, and contains occasionally stray pieces of fossil damar resin. It carries very small amounts of fine cassiterite and considerable magnetic and red oxide iron sand. In the lower layer, which is separated from the upper by a thin, often only slightly marked, seam of gray clay from 1 to 2 inches in thickness, the nature of the quartz gravel is the same as above, but carbonized wood is absent, the amount of iron sand is smaller, and that of cassiterite is larger. This layer is locally known as the pay seam. Small crystals, or crystalline fragments, of spinel and ruby, but no tourmaline, garnets, topaz, or mica, were noticed. The cassiterite is to a large extent semicrystalline, and crystals are by no means rare. Both the tin ore and the quartz show little average wear of corners and edges, indicating that they have been transported but a short distance only. Underlying the quartz gravel is a tough gray or greenish-gray clay of varying thickness, which gradually passes into decomposed rock in place from 3 to 4 feet thick. Below this lies the true bed rock, an impure sandstone of the nature already described. The tough gray clay underlying the quartz gravel is the bed rock for working purposes. As is usual in creek beds and their adjacent banks, unevenness in the bed or pot holes occur, in which there is generally an extra accumulation of tin ore. In figuring the thickness of the gravel and its corresponding richness they must be considered. By a simple computation (the tons of quartz gravel worked from a given area being known) it is ascertained that the average thickness of the pay quartz gravel, including the pot holes, is about 6.5 inches, or 0.54 foot, in the Batang creek, with an average overburden of 4.93 feet. This creek had been selected to begin operations on as offering the best inducements. The pay gravel yielded "black tin" (averaging 70 to 72 per cent in "white" or metallic tin) at the rate of 2.7 pounds per ton of 2,240 pounds, or 0.12 per cent. Calculated on the total amount of ground excavated, including the stripping, this would be 0.476 pound black, or 0.348 pound white tin per cubic meter excavated. In Banca, according to Van Diest, the same amount of excavation yields 2.2 to 3.33 kilograms black, or 1.75 to 2.03 kilograms (2.95 to 4.46 pounds) white tin.

The relative proportion of pay gravel to entire stratum removed is at Banca, 3 to 33 feet; at Kotta Ranah, 0.54 foot to 5.47 feet, or practically the same. The advantage of a lighter covering in the latter place is neutralized by a reduction of yield in about the same proportion. The economical limit of mining is naturally different in the 2 places, depending largely on surrounding conditions, mechanical facilities, and the cost and efficiency of labor.

In Banca, the amount of ground removed per annum by 1 man is, according to Van Diest, 300 to 450 cubic meters. At Kotta Ranah it is 205 cubic meters in cleared, dry ground, and 196.68 in cleared but ordinary ground. The average yearly product of 1 man in Banca is 610 kilograms white tin. Hydraulic stripping can not be introduced at Kotta Ranah for lack of head and grade. The maximum width of the pay channel is about 200 feet; the average probably 35 feet. The streams are short, and if mechanical devices were used in stripping they would have to be moved frequently. Pannings were made of nearly 10,000 pounds of gravel from the different creeks. 20 per cent of the pannings were rejected as too low, or as lying outside the limits of the tin-bearing channel, the remaining 80 per cent gave an average result of 1.13 pounds metallic tin to 2,240 pounds of stream gravel, or 1.75 pounds per cubic meter. The distribution of the cassiterite through the creek beds of this district is somewhat unusual in character. One would expect the fine ore to be found down stream and the coarse ore upstream, according to the laws governing the disposition of sediments; but in this examination it is found, on the contrary, a perceptible decrease in the average size of the grains, going upstream, within a certain limit or belt. Going beyond this limit there was a positive decrease, both in the coarseness and quantity of the tin grains. An absolute unsized condition, so to speak, of the tin grains in the creek beds within this belt or zone was also noticed, while outside of it the tin would either be extremely fine and but little of it, or no tin at all would occur. (Upper Lau and Rambei.) Within the belt coarse tin ore would be found in the creek beds a few feet beyond fine ore, and, vice versa, there seemed to be an utter absence of regular sizing. In some of the streams, notably the Petaling, Kalomboi, middle Quay, and upper Blevon, grains or crystals of cassiterite were found still clinging to small, angular, or sharp pieces of quartz which appeared crystalline and drusy under the microscope. This indicates that the tin ore now found in the streams has been broken down from veins of quartz not far away. In some instances (Petaling and Blevon) the veins must be very near. Considering also the angularity and size of the quartz gravel in the creek beds and banks, and the absence of mica and tourmaline, one is inclined to think the existence in the indurated sandstones of narrow quartz veins carrying cassiterite, which have furnished the stream tin, to be a not unreasonable hypothesis. By plotting the results of the test pannings a tin belt is defined with a northwest and southeast trend. This indicates that the course of the stanniferous quartz veins (from which the stream tin came) corresponds with the general axis of upheaval of the country. The nature and unsized condition of the detrital material points to an occurrence of these veins in the sandstones lying but a short distance above the marked belt, or even within it. Corroboration bordering on proof is furnished by the absence of quartz gravel in the upper Lau (toward its headwaters), and the occurrence, instead, of micaceous and fissile sandstone in pieces of rounded and angular shape. Similar but less marked conditions occur in the upper Rambei stream, while in the upper Batang and other streams all gravel disappears.

It thus appears that the Kotta Ranah-Rambei alluvial tin field is of very recent origin, being derived from the broken-down outcrops of narrow stanniferous quartz veins, which occur in the underlying and adjacent impure sandstone, in a probably northwest and southeast direction. They are likely to extend at intervals into adjoining districts. That there really are narrow quartz veins in the underlying sandstones (though what was seen was not stanniferous) was proven when a pit was sunk in the kulit of Batang creek, extending into the decomposed rock in place. A nearly vertical 2-inch veinlet of quartz was carried in one side of it. The quartz now found in the creek beds is, of course, part of the broken down outcrops of veins. The surrounding country indicates that erosion has taken place to a minimum depth of several hundred feet. The heavy tropical floods carry, as a matter of fact, the finer and lighter tin ore to the larger streams and their flood plains, and it is not surprising that traces of tin ore can be found even at long distances from their probable source. Unquestionably there exist other and similar belts in Siak. Tin ore in the streams of the northwest part of the concession and beyond, near to Rohkan river, have been heard of, but no test of their value and extent has been made. A systematic further tracing of the belt may lead to the discovery of richer fields in Siak than the one described.

For comparison some figures are introduced from another foreign field, the Kong Loon Kongsi mine, on the Malay peninsula, in the district of Kamounting, Perak, as reported by Mr. M. J. Errington de la Croix in Les mines d'étain de Pérak. A Chinese company is working the field under a concession, and the formation may be taken as typical for that district.

At this place a cross-section through the alluvium shows:

| | METERS. | |
|---|---|---|
| Humus | 0.20 | Strippings, 3.5 meters. |
| Yellow clay | 0.90 | |
| Sand with tourmaline grains | 0.70 | |
| Gray clay | 0.65 | |
| Gravel, quartz, feldspar, tourmaline | 0.25 | |
| Reddish ferruginous clay | 0.50 | |
| Sand | 0.15 | |
| Yellow clay | 0.75 | |
| Tin deposit with bowlders | 2.80 | Pay gravel, 2.8 meters. |

The pay gravel bed averages 1 per cent in metallic tin. From Mr. De la Croix's figures it appears that 44.4 per cent of the material excavated is useful material and the remaining 55.6 per cent is waste. He says it requires 41 cubic meters (1,600 kilograms) of pay gravel to make 1 ton of black tin ore assaying 66 per cent white metal. Hence it must require 92.48 cubic meters of excavation from grass roots to bed rock to furnish the 41 cubic meters of gravel required. This costs $1.18 (Mexican money) per cubic meter of gravel.

From other data in the report it is calculated that 1 man removes in that mine 343 cubic meters of ground per year. The work performed at the Kong-Loon mine is raising 16 kilograms (the weight of a basketful of gravel) a maximum of 6.30 inches, with a velocity of 5 centimeters per second. The day's work amounts to about 6.5 hours. The work performed is then 0.80 kilogrammeter per second, or 18,720 kilogrammeters per day. At Kotta Ranah the workmen raise only (average of 56 observations) 11.6 kilograms (25.59 pounds) a maximum of 1.72 meters, with an average velocity of 3 centimeters per second, or the duty performed is 0.348 kilogrammeter per second, or 9,605 kilogrammeters per day's work of 7.66 hours. The class of workmen and the discipline and organization are evidently superior at Perak, but the duty performed even there is only about one-third of that of white labor in temperate climates. In view of this large difference in effective work, a few words as to the system of mining labor in the east are given. The ordinary workmen employed for mining and allied occupations are Chinese, who are either imported direct by the employers or are obtained more generally through Chinese agencies, which exist in different parts of the east. These agencies import the men direct from China, at their own expense, under contract, and then sublet them to individuals or corporations, at a fixed cash price per head (supposed to cover expenses and profit of the importing agencies) and under agreed and stipulated conditions with their employers, which are signed by both parties and attested in the presence of the "Chinese protector" (*a*). The wages of the ordinary cooly are $30 (Mexican money) per year, $18 of which is advanced to him upon enrollment. The agency in Singapore receives in addition a cash payment of $20 for a 12-months' cooly. At the termination of his contract the laborer becomes an "old" or "free cooly" and is at liberty to re-engage of his own volition, at a previously agreed price, to the same party, or make his own terms elsewhere, or return to the town whence he came. As a novelty to American miners, a copy of one of these contract forms is given:

It is this day mutually agreed between the employer, the A. B. C. Company, his attorney, heirs, or assigns, and Tu-Tru, Chinese laborer, born at ——, and aged —— years:

That the said laborer is willing to proceed to Kotarana Sumatra and be employed there as a tin miner for 12 months, at a yearly wages of $30 subject to the following conditions, viz:

1. That the said laborer receives an advance of $18, which shall be deducted by instalments by the employer, at the rate of $1.50 per month.
2. That the expenses for conveying the laborer to his destination shall be borne by the employer.
3. That the said employer shall furnish the laborer with a suitable house, for which the latter will not be required to pay rent.
4. That the said employer shall provide the laborer with his daily food, and also furnish him with 1 jacket, 2 pairs short trousers, 1 mosquito curtain, 2 bathing cloths, 1 sun hat, and a pair of clogs.
5. In the event of the laborer falling ill from natural causes, the employer shall furnish him with medicine and a place for his medical treatment until recovery, and if the days of illness do not exceed 30 days the loss of time shall be borne by the employer, and the laborer will not be required to make up for it; but should the illness of the laborer exceed 30 days during 1 year or should he fall sick from his own fault, or contract any venereal disease, he shall, on recovery, or after the termination of his agreement, make good the days of his illness, and shall also pay to the said employer 27 cents as costs of food for each day's absence. Should the laborer desert and be captured all expenses actually incurred shall be repaid by him.
6. Should the laborer be unable to work on account of venereal disease, or stop work through laziness, the number of days of such absence, together with any advances he may have received, shall be indorsed on the contract, and should there be, at the expiration of the agreement, any sums outstanding, the laborer shall work at the rate of $6 per mensem, as in the case of old coolies, until the whole amount has been paid.

Whenever there is any dispute, the agreement shall be taken to the protector of Chinese, or, if beyond this colony, to the local authority.

7. 10 hours shall constitute a day's work, but in case of emergency the laborer shall work beyond the specified time. Such overtime shall be placed to the credit of the laborer at the rate of wages mentioned in his contract.
8. The customary Chinese festivals will be considered as holidays.

The above eight articles having been clearly explained to both parties by the protector of Chinese, they have agreed to all of them and have signed this contract with the understanding that they shall hereafter observe all the articles mentioned therein.

Register No. ——; name in English of employé, —— ——; age, ——; name in Chinese, —— ——; original country, ——; advance, $——; signature or mark of employé, —— ——.

Office of protector of Chinese, ——, 18—,

—— ——, *Employer.*

—— ——, *Witness.*

—— ——, *Protector of Chinese.*

Coolies introduced into the Dutch possessions must have their contracts filed and registered by their employers with the nearest "resident" or "assistant resident". The Dutch law does not permit coolies to be worked without a contract, and requires a proper enforcement of its stipulations. So long as coolies live up to their contract they can not be dismissed before its expiration without the consent of the "resident". This is an important matter to the promoters in case of an unprofitable enterprise. Coolies work under foremen called mandors, distinguished as first, second, third, or fourth mandor, according to their ability and duration of service and to the number of men under them. In Siak each mandor worked 50 coolies. Mandors' wages vary from $100 down to $70, $60, or $40 (Mexican money) per month. The mandors are supposed to board themselves. They are paid from 1 to 2 months' wages on account on enrollment. Mandors are picked from among "old" or "free" coolies. The wages of Chinese blacksmiths (free) vary from $20 to $25 per month, and carpenters cost, according to skill, from $15 to $25 per month.

To these wages must be added the cost of brokerage, agency, contract drawing, medical examination, and other items; also the cost of shipping coolies to their destination and feeding them en route. The monthly board, either provided by the employer direct or through a boarding-house boss (tauki), against a fixed charge, must also be included. If a cooly dies during contract time, the $20 purchase money and any part of the $18 advance not yet worked out is lost to the employer. Moreover, the time lost through sickness of less than 30 days, the cost of medicine administered (see contract), the hospital cost for patients ill more than 30 days, and the eventual funeral expenses and loss of clothing supplied, are all charges to be considered when the cost of a unit of labor is computed. The time lost during heavy rains (the coolies working out of doors), when calculated for a lot of coolies per year, represents a good many days' work. Adding to all this the necessity of breaking in raw coolies for their especial work, it is concluded that cooly labor is more expensive than might at first have been supposed.

The hours of work in Siak are from 7 to 11 a. m. and from 1 to 5 p. m. About 10 minutes are lost each time on going to work and getting ready. The cooly's work is reckoned to commence when he leaves his roof or shelter.

Coolies in Siak are paid once a month, nominally $2.50, but $1.50 is kept back on account of the advance made at enrollment, leaving the cooly $1 in cash per month during his year of employment. There are no rates per hour, such as are established for overtime in the Malay peninsula, where the whole cooly labor system, being of longer standing, is better organized and disciplined than in Siak.

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[a] The Chinese protectors are government officers, appointed to enforce the fulfillment of labor contracts and to take the part of the wronged party, if occasion requires.

The tools of the Chinamen are a chankol, a hoe-like instrument, which takes the place of the pick and shovel, and a crowbar, for harder material or bowlders. The material excavated is filled with the chankol into small, flat rattan baskets (bakol), which are carried across the shoulders, being hung back to back, so as to be easily dumped by either hand. Notched poles, similar to those used in Mexico, serve as ladders in the pits.

To raise small quantities of water, or to hoist from the deeper pits, the old-fashioned "well-sweep" is used, with a thin rattan vine for a cord, carrying for the former purpose a bucket, for the latter a larger bakol than is used for carrying dirt and gravel by hand. The Chinese pump is also employed. Steam pumps have been introduced in the Malay peninsula.

In addition to the Chinese miners, small numbers of Javanese coolies are employed in Siak for making roads and grubbing out the roots of trees, and the native Malays find work in clearing the jungle and forest, carrying supplies over the rough roads, building native huts, cooly houses, stockhouses, etc. The Javanese coolies are, like the Chinese, under time contracts, but they feed themselves, procuring supplies from the natives. The Malay workmen are free men, independent in their actions and character, and better suited to their special work than either of the other 2 races. The 3 races live apart, and there is no love lost among them. Malays are paid 33.3 cents a day, and feed themselves.

Storehouses, cooly houses, etc., are framed of rough timbers and heavy sticks, the sides being of bamboo laths covered with bark or atap (a variety of palm leaf). The floor is made of closely-laid bamboo sticks, and the roof is covered with atap. The following example shows the number of days' work required to build, as far as the lower edge of the roof, a storehouse (godang) 14 meters long, 8.5 meters wide, and 2.7 meters high, and raised on posts 1 meter high from the ground. The jungle was cleared for a considerable distance around the house.

| | DAYS' WORK. |
|---|---|
| Clearing jungle | 24 |
| Grading | 46 |
| Cutting and carrying to camp: | |
| Timbers | 326 |
| Sticks | 49 |
| Atap | 350 |
| Rattan vine | 150 |
| Bark | 12 |
| Bamboo | 57 |
| Extra wall material | 41 |
| Preparing atap in camp | 262 |
| rattan in camp | 154 |
| wall material in camp | 120 |
| Labor of erection | 364 |
| Total | 1,955 |

At 33.3 cents equals $651.66.

A dwelling house, 11 by 8.5 by 2.3 meters, with kitchen attached, 5 by 5 by 2.5 meters, cost 324 days' work. Both buildings were rain proof.

The Banca miners of alluvial tin distinguish two classes of work: the mountain stream work, called kulit, and the working of valley placers and flats, called kollong. From this has also grown the custom of calling work on an upper gravel layer kulit, and on a lower one kollong; work on an intermediate layer being called kulit-kollong. In Siak, Sumatra, kulit work only exists. This work is performed, after the necessary preliminary cleaning and grubbing, by Chinese coolies, and consists in first diverting the stream and then making upstream a series of rectangular excavations (kulit), taking in, if possible, the full width of the pay channel or working from bank to bank down to and through the pay gravel, but keeping the strippings separate. After staking off a rectangle of the width of the gulch or pay channel, and, say, 100 feet in length, a number of Chinamen are placed, chankol in hand, along the lowest line across the gulch, facing upstream. These loosen the ground and fill it into the baskets of the stripping carriers (angkat tanna), who stand behind the diggers (chankol tanna) and have to carry the waste back of the field to the dumping ground. When the staked area has been stripped down to the pay gravel or karang, this is taken out similarly and carried to the ore or karang floor (*a*). A new pit is then commenced, and the strippings of the new work are dumped into the first excavated and now empty pit. When the work is in full operation there are distinct squads of strippers and pay-gravel diggers with their respective squads of carriers, distinguished as orang tanna and orang karang. The gravel is constantly tested, at different places, by washing (in the batea) to guide the diggers.

As already observed, the baskets at Kotta-Ranah in which the material is carried out of the pits are small, holding only 25 pounds; in Perak the carrier's load is 35 pounds, and in Pahang 37 pounds. If light iron wheelbarrows were substituted, and planks laid to wheel on, a carrier, in these shallow deposits, could just as easily wheel out from 60 to 70 pounds in the time he now consumes in carrying 25 pounds. The Chinaman, however, dislikes any innovation upon his accustomed ways, and much prejudice was encountered on the part of the mandors when the trial was suggested. They were, however, finally persuaded and convinced that the assertion was correct; but it was soon learned that, besides prejudice, superstition had to be overcome with the Chinese tin miner. The tales of mining kobolds and gnomes still hold full sway in their minds. They believe that tin is under the especial protection of gnomes who are easily offended, and who, if established ways are not strictly adhered to, leave the mine and take the tin with them. One very disagreeable thing exacted by these gnomes is that when karang is being dug no one shall enter the kulit except barefooted. Now, this is the most interesting stage in the work for one who wants to study the deposit, and it surely tries an expert's enthusiasm to be obliged to walk barefooted over muddy angular quartz gravel for each sample to be panned. Again, while pay gravel was being dug, it was not permitted to approach the ore floor or the kulit with an opened umbrella to shield against rain or the tropical sun. The mandor said "the tin would leave the gravel over night". At each starting of a new kulit, or of the wash machine, tapers were burned at each end, formulæ were said in Chinese, and the wash machine was treated to a handful of rice, carefully dropped into the feed water. It required patience and time to overcome these superstitions. Though impressed by the washing of tin out of the gravel in a gold-miner's pan, the coolies did not give their confidence until a prospecting borer was brought out and started, which, to their surprise, brought up tin without stripping in the regular way. It was permitted after this to keep one's shoes on, but still one had to forego the luxury of an umbrella about the diggings.

Another evidence of either superstition or extraordinary mutual affection is presented by the death register. Each cooly receives a number on enrollment, which is carried for identification; in addition, each man is photographed, and his number is written on the picture. Friends generally take consecutive numbers. I was struck to see how death selected certain sets, nearly by consecutive numbers, such as 9322, 9324, 9325, 9326, 9328, 9344, 9346, 9347, 12513, 12515, 12517, 12519, 12520, 12541, 12542, 12543.

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*a* Karang really means "rock", and is used in this connection as our lode miners speak of "pay rock", in contradistinction to tanna or earth. Angkat means carrying or carried.

The simple and crude borer used in the east for prospecting alluvial deposits consists of a circular iron platform with a central annular opening, and a projecting sleeve on the under side large enough to slip over the casing tube, to which it is held by 3 heavy screw bolts. The casing has couplings with slot key seats or common screw couplings. The pipe used was 3.5-inch cast iron, with a projecting steel shoe for the end piece. Boring-rods were 1.5-inch square bar iron, with a screw socket top. The bit of the boring tools is 3 inches in diameter, there being a variety of bits in each outfit. Besides a large auger to start the casing hole, there are screw augers, augers with ball valves, screw-nosed cylinders with ball valves, a T-shaped wood-cutting chisel, semicircular, cross, and flat chisels for rock or bowlders, crown borers, sand borers, and a variety of other tools, such as rod catcher, spring darts for tubing, etc. These tools might be much improved. The price of such an outfit at Singapore is about $685 (Mexican money). In the iron platform, arranged along the circumferences of a series of concentric circles described about the central coupling, are a number of 1-inch holes intended to permit the attachment of weights to the platform by means of hooks or lashings. When the casing has been started several feet into the ground, and a guiding frame has been built about it, 4 men mount the platform, insert the boring tools into the casing, and, walking in a circle, turn the rods by means of hand dogs. The weight of the men and platform plus the weights attached below forces the casing down as the boring tool cuts the material away. The casing, which is fastened to the platform, turns in an opposite direction from the borer by virtue of the circumstance that the men brace their feet simultaneously against the platform as they press on the hand dogs. To guide the rods and to facilitate the lengthening and extraction of rods and tubing, a tripod, rigged with blocks and falls, is erected over the bore hole. The number of feet bored per hour varied according to the nature of the ground and the kind of bit. With an entirely raw crew, the average progress was from 1.33 to 2.06 feet per hour, and the time occupied in loosening, extracting, lengthening rods and tubes, etc., and necessary delays varied from 2.27 to 11.9 times the actual boring time. The average progress of 1.33 feet corresponds to the smaller ratio of 2.27 just given. In this case a cylindrical open shell with screw-nosed end was used as a bit. When 2.06 feet average progress was made per hour a regular screw auger was used. This would tighten frequently, and the necessary delays amounted to nearly 12 times the actual boring time, but the net rate of progress was greater. In both cases the soil was a tough, gray clay. The depth of holes varied from 11 to 32 feet. The crew comprised 11 men, 4 on the platform, 6 extracting, handling rods, tubes, etc., and 1 panning the borings.

In Banca and Billiton, where the coolies have been trained for years by Europeans, conditions are different. In Billiton there is a regular boring corps in charge of European engineers, which tests the fields systematically in advance by boring first at intervals of, say, 100 yards, and supplementing these with holes 20 to 25 yards apart, or closer, if necessary, to ascertain the course, average thickness, and character of pay gravel. The contents of each bore hole are carefully washed, the collected tin is weighed, and calculations are made as to the probable yield. On the basis of this estimate the fields are let out to Chinamen, against a fixed price per unit weight of tin produced (*a*) and turned over to the company.

It has been established that the average wages expended in Billiton per pikol of tin ore produced is 20 guilders, and that 12 guilders per pikol is the cost of administration, etc. On the basis of these figures and the indications of the test borings a certain tariff is figured out, with contingent bonuses.

Under a former tariff the basis of wages was 20 guilders per pikol of tin ore, but the workman received, as minimum wages per annum, 140 guilders, or the pay for 7 pikols, whether he produced so much or not, 7 pikols being the lowest rating of annual yield per man. If he delivered the full rated quantity or more, he received a bonus determined in a sliding scale, in addition to the regular wages of 20 guilders per pikol. The sliding scale was as follows: for ground rated to yield annually 7 pikols per man, the bonus paid, besides wages, to each man delivering the rated quantity or more was 80 guilders; for 8-pikol ground 65 guilders, 9-pikol ground 50, 10-pikol ground 35, 11-pikol ground 20, and 12-pikol ground 5 guilders as bonus. The reward, as will be seen, is very properly largest for the man working in the poorest ground, as workmen in richer ground, even if they do not secure the bonus, are pretty certain of getting more than the guaranteed minimum of 140 guilders. The present minimum in Billiton is 120 guilders per year, representing 6-pikol ground, and the above sliding scale has probably been correspondingly altered. The pay gravel at Kotta Ranah is sufficiently free from clay not to require puddling. It is washed in a sluice box 18 feet long, 3 feet wide at the head and 1 foot 5 inches wide at the tail, having a slope of 3°. Above the sluice box a cylindrical sizer, 1 foot 6 inches in diameter and 3 feet long, made of 0.5-inch square bar iron, and having a slope of 1 inch to the foot, is connected by shafting with an overshot water wheel. Three-fourths of the water required in sluicing is passed in with the gravel at one end of the drum, the remaining quarter drops from above from a perforated launder onto the revolving drum, which it enters through the 0.25-inch spaces, washing the coarser gravel clean. The coarse gravel is discharged at the opposite end of the drum, which has a turned-up flange 0.5 inch high, to prevent a too rapid discharge of the gravel and insure a better washing. The fine stanniferous gravel falls through the 0.25-inch spaces upon an apron 2 feet 5 inches long, inclined 23°, and provided with distributors. This apron is continued for another foot, to the head of the sluice, but at 60° inclination. The gravel is raked with a flat, narrow wooden shovel or with forks, and is afterward skimmed. The concentrates are cleaned in the batea. This combination of sluice and sizer was copied from Australian mines.

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[a] The unit of weight on which tin ore is bought and sold in the East Indies is the pikol. The following table of native weights is compiled from the Netherland Indies government almanac for 1890:

| | | KILOGRAMS. |
|---|---|---|
| 1 pikol = 100 katties | = | 61.763 |
| 1 kattie = 16 thails | = | 0.616 |
| 1 thail precious metal | = | 0.054 |
| 1 koyan = 28 pikols (Samarang) | = | 1,729.316 |
| 1 koyan = 27 pikols (Batavia) | = | 1,667.555 |
| 1 koyan = 30 pikols (Soerabuja) | = | 1,852.839 |
| 1 koyan = 30 pikols (Batavia, for salt, etc.) | = | 1,852.839 |

The following are the figures for the Malay peninsula, as given by E. de la Croix:

| | | KILOGRAMS. |
|---|---|---|
| 1 pikol = 100 katties | = | 62.500 |
| 1 kattie = 16 thails | = | 0.625 |
| 1 thail | = | 0.039 |
| 1 bharra = 3 pikols | = | 187.500 |
| 1 koyan = 40 pikols | = | 2,500.000 |
| 16 pikols = 1 metric ton | = | 1.000 |

At Singapore:

1 pikol white tin metal = 60.5 kilograms = 133.33 pounds avoirdupois.
16.8 pikols = 2,240 pounds avoirdupois = 1 ton.

The capacity of such an apparatus, when the gravel is not clayey, was found to be 5,826 pounds wet or 5,194 pounds dry gravel per hour. This average was obtained from a run of 174,786 pounds of weighed gravel.

The labor required for washing and weighing per day was: 1 man at ditch; 1 man wheeling away tailings; 1 man taking away coarse gravel and attending to transmission of power, etc.; 4 men washing; 2 men feeding drum on ore floor; in all, 9 men; 1 man weighing ore; 2 men carrying weighed ore to drum floor, and half the time of 1 mandor. It will easily be seen that with proper arrangements at least 4 men could be dispensed with. Tailing samples from the sluice box contained 0.2 pound of black tin per ton of pay gravel. Singapore smelting charges, on long time contracts, are indicated by the appended sliding scale:

Ore assaying 70 per cent and over, gross price $1.50 per pikol, or $25.20 per ton.
Ore assaying 65 per cent and over, gross price $1.75 per pikol, or $29.40 per ton.
Ore assaying 60 per cent and over, gross price $2.00 per pikol, or $33.60 per ton.

Ores containing sulphur, copper, or iron pyrites, arsenic, or other impurities, requiring special treatment, must be specially arranged for. The charge for roasting is 55 cents per pikol extra. The deductions are, first, a small percentage for impurities, and then for loss in furnace. Deductions for trifling impurities usually vary from 0.2 to 0.5 unit, and for smelting losses the deductions are:

| On ore assaying— | DEDUCTION. (Units.) |
|---|---|
| 70 per cent and upward | 2 |
| 65 per cent and upward | 3 |
| 62 per cent and upward | 4 |
| 60 per cent and upward | 5 |

For example, on a high-class ore, assaying, say, 74.2 per cent of tin, there would probably be deducted 0.2 for impurities and 2 units for loss in furnace, leaving 72 per cent net refined tin. On ore assaying 72 per cent and quite pure, possibly 70 per cent net refined tin would be allowed, but more likely 69.5 per cent. It will be seen that the losses thus charged are quite severe when the ore falls below a 70 per cent grade. Assuming the deduction for impurities at 0.5 unit, the losses charged really are:

| For ore assaying— | PER CENT. |
|---|---|
| 70 per cent and over | 3.57 |
| 65 per cent and over | 8.46 |
| 62 per cent and over | 10.46 |
| 60 per cent and over | 12.50 |

The smelters use furnaces similar to those of Cornwall. There should be a handsome profit in these charges. Their only competitors are the Chinese smelters in the local camps.

Mr. E. de la Croix gives the rates at Perak. The tin ore there is pure but fine, and contains no arsenic and seldom sulphur. An analysis of the Kong-Loon mineral shows tin, 66; iron, 6.15; silica, alumina, etc., 27.85. The single smelting, which suffices for the reduction of the stannic oxide to metal, is performed in a low semicylindrical shaft furnace (spurofen) of brick, 45 centimeters in diameter and 1.85 meters high above the hearth level, with 1 tuyère inclined 40° to 45°, the whole costing about $100. Smelting is done at night; 36 pikols, or 2.25 metric tons, of mineral are treated per night, with a consumption of 1,203.125 kilograms of charcoal (53.47 per cent). The costs per pikol are $0.55 for labor and $2.30 for fuel, a total of $2.85. The losses in treating 66 per cent mineral are 7.60 per cent (much of the mineral being very fine). The slags made are ground and washed for metallic granules, or sold to special smelters. Mr. De la Croix gives the following analysis of washed and unwashed slags:

| COMPONENT PARTS. | Unwashed slags. (Per cent.) | Washed slags. (Per cent.) |
|---|---|---|
| Tin (metallic granules) | 5.30 | 55 |
| Tin silicate | 8.60 | 15 |

This shows that much of the silicate of tin was lost in washing.

The Chinese-built furnaces of Billiton are made of clay. A similar one was seen in Sumatra. They are short, cylindrical shaft furnaces, 12 to 15 inches in diameter, and 3.5 to 5 feet high from lowest hearth level to throat. The hearth bottom is spherically rounded, and a tuyère hole is provided above for artificial blast.

The Chinese generally smelt during the 4 months of the wet season, from December to April, and during the night. They commence preheating the furnace at about 3 p. m., charge at 7, and at 9 the charge is fused. The campaign of a set of 2 furnaces, costing when erected about 200 guilders each, is, say, 2,000 pikols, which are run through in 80 to 90 nights. Hence the furnace wear per day is about 5 guilders. 27.5 pikols smelted is considered a large night's work. The cost is about 2 guilders per pikol, or per day 53 guilders, divided as follows: Fuel, 40; wear and tear, 5; wages, 8. The latter item includes 1 head smelter, 4 assistants, 3 bellows men, and 2 roustabouts, making 10 men, at average wages of 25 florins per month.

Only about one-fourth of the Billiton tin requires refining. The black tin averages 71 per cent in white metal, and the loss in smelting was given at about 3 per cent.

What is known to the trade as Singapore tin comes partly from Perak, partly from Sungi Ujong, Selangor, Kwalla Lumpur, Jelubu, and Malacca. Pahang is expected to add to the Singapore output hereafter. What is known as Penang tin is all from Perak (part of the Perak tin goes to Singapore). What is known as Straits tin in London is Penang and Singapore tin. What is known as Malacca tin in the United States is also Penang and Singapore tin, only it is specially branded to satisfy the American buyers. It may seem strange that Penang tin is sent to Singapore in preference to exporting it direct, since freight rates from Penang to Singapore are 8 cents per pikol; insurance, 0.125 per cent; exchange and banker's commission, 0.125 per cent additional. If tin is quoted in Singapore at, say, $31.50 per pikol, the extra shipping, costs, etc., from Penang would be 16 cents per pikol. Singapore overcomes this drawback of 16 cents by having better shipping rates and more favorable banking facilities. The shipping rates in September were as follows: To Holland, 15 shillings per ton; to United States, 21 shillings; to London, 7 shillings 6 pence. Insurance costs 0.250 to 0.375 per cent.

The mines of Cornwall and Devonshire furnish nearly one-fifth of the total supply. These mines are too well known to require description. They furnish the principal guide as to the lowest limit which can be reached in the percentage of tin in the ore with a resulting profit in the mining, even where the cost of wages, etc., is low.

## PRODUCT OF TIN STUFF (CRUDE ORE) AND ITS PERCENTAGE OF METALLIC TIN FROM CERTAIN ENGLISH TIN MINES.

| YEARS. | Number of mines. | Tin ore. (Short tons.) | Black tin. (Short tons.) | Per cent of black tin. | Metallic tin. (Short tons.) | Per cent of metallic tin. |
|---|---|---|---|---|---|---|
| 1883 | 15 | 8, 203 | 159 | 1. 94 | 102. 27 | 1. 24 |
| 1884 | 9 | 4, 508 | 66 | 1. 46 | 41. 80 | 0. 93 |
| 1885 | 8 | 2, 367 | 78 | 3. 30 | 50. 66 | 2. 14 |
| 1886 | 12 | 3, 468 | 87 | 2. 51 | 56. 92 | 1. 64 |
| 1887 | 15 | 3, 812 | 102 | 2. 68 | 66. 72 | 1. 75 |
| 1888 | 13 | 3, 653 | 68 | 1. 86 | 43. 72 | 1. 20 |
| 1889 | 20 | 6, 497 | 134 | 2. 06 | 86. 48 | 1. 30 |

## TOTAL PRODUCT OF BLACK TIN AND ITS YIELD IN METALLIC TIN IN CORNWALL AND DEVON COUNTIES, ENGLAND.

| YEARS. | BLACK TIN. | | METALLIC TIN. | | YEARS. | BLACK TIN. | | METALLIC TIN. | |
|---|---|---|---|---|---|---|---|---|---|
| | Quantity. (Tons.) | Value. (Pounds sterling.) | Quantity. (Short tons.) | Value. (Pounds sterling.) | | Quantity. (Tons.) | Value. (Pounds sterling.) | Quantity. (Short tons.) | Value. (Pounds sterling.) |
| 1859 | 10, 180 | 731, 315 | 6, 497 | 850, 452 | 1875 | 13, 995 | 735, 606 | 9, 614 | 866, 266 |
| 1860 | 10, 400 | 812, 160 | 6, 656 | 866, 306 | 1876 | 13, 688 | 600, 923 | 8, 500 | 675, 750 |
| 1861 | 10, 963 | 793, 698 | 7, 016 | 857, 706 | 1877 | 14, 142 | 572, 763 | 9, 500 | 695, 162 |
| 1862 | 11, 841 | 777, 396 | 7, 578 | 879, 048 | 1878 | 15, 045 | 530, 712 | 10, 106 | 663, 080 |
| 1863 | 14, 224 | 943, 387 | 9, 104 | 1, 065, 168 | 1879 | 14, 665 | 586, 600 | 9, 532 | 689, 163 |
| 1864 | 13, 985 | 881, 031 | 9, 295 | 995, 029 | 1880 | 13, 737 | 673, 113 | 8, 918 | 813, 767 |
| 1865 | 14, 122 | 782, 284 | 9, 038 | 873, 659 | 1881 | 12, 898 | 696, 492 | 8, 615 | 839, 639 |
| 1866 | 13, 785 | 667, 999 | 8, 822 | 781, 849 | 1882 | 14, 170 | 813, 003 | 9, 300 | 992, 310 |
| 1867 | 11, 066 | 549, 375 | 7, 296 | 670, 228 | 1883 | 14, 469 | 735, 189 | 9, 307 | 903, 476 |
| 1868 | 11, 584 | 641, 137 | 7, 703 | 756, 494 | 1884 | 15, 117 | 669, 254 | 9, 574 | 809, 740 |
| 1869 | 13, 883 | 889, 378 | 9, 356 | 1, 138, 488 | 1885 | 14, 377 | 662, 390 | 9, 331 | 833, 803 |
| 1870 | 15, 234 | 1, 002, 357 | 10, 200 | 1, 299, 505 | 1886 | 14, 232 | 780, 302 | 9, 312 | 944, 470 |
| 1871 | 16, 898 | 1, 068, 733 | 11, 320 | 1, 556, 557 | 1887 | 14, 189 | 878, 831 | 9, 282 | 1, 048, 633 |
| 1872 | 14, 266 | 1, 246, 135 | 9, 560 | 1, 459, 990 | 1888 | 14, 370 | 894, 665 | 9, 241 | 1, 083, 700 |
| 1873 | 14, 885 | 1, 056, 835 | 9, 972 | 1, 329, 766 | 1889 | 13, 809 | 729, 213 | 8, 912 | 860, 342 |
| 1874 | 14, 039 | 788, 310 | 9, 942 | 1, 077, 712 | | | | | |

**Australia.**—The discovery of stream tin in Australia and its subsequent rapid development attracted great attention while the stream-tin deposits remained rich, but as the best portions were rapidly exhausted the region has taken a minor position on account of the inability or disinclination of the miners to attack the lodes from which disintegration furnished the rich stream deposits.

# NICKEL AND COBALT.

# NICKEL AND COBALT.

During the year 1889 ores containing nickel and cobalt were produced at Lancaster Gap, Pennsylvania, at Mine La Motte, Missouri, and at Lovelock station, Nevada. The great feature of the year was the diversion of all attention in nickel mining to the nickel-bearing copper ores of the Sudbury region in Canada. The course of development showed conclusively that nickel can be produced there for a less cost than anywhere else in the world, so far as the present capacity of the known mines permit of an opinion. In spite of the fact that this favorable outlook for nickel production in Canada has kept the more experienced nickel producers from investing elsewhere, there has been much activity in prospecting for nickel at various points in the United States, owing to the successful tests of armor plates of nickel steel.

## NICKEL MINING IN THE UNITED STATES.

The following statements in relation to nickel mining show the number of employés engaged in this industry in 1889, rates of wages and number of days worked, expenditures, capital invested, power used, and the product and value of nickel:

### EMPLOYÉS.

| CLASSIFICATION. | Number. | Usual rate of wages. | Number of days worked. |
|---|---|---|---|
| Total | 187 | | |
| Above ground: | | | |
| Foremen | 2 | $2.61 | 201 |
| Mechanics | 16 | 2.02 | 215 |
| Laborers | 85 | 1.11 | 262 |
| Boys | 10 | 0.60 | 290 |
| Below ground: | | | |
| Foremen | 2 | 3.30 | 336 |
| Miners | 33 | 2.45 | 265 |
| Laborers | 33 | 1.40 | 274 |
| Office force: | | | |
| Males | 6 | | |

### EXPENDITURES.

| | |
|---|---|
| In wages | $84,200 |
| Paid to contractors | 2,000 |
| Paid to office force | 9,600 |
| Total | 95,800 |
| Paid for supplies | 29,236 |
| Other expenditures | 1,151 |
| Total expenditures | 126,187 |

### CAPITAL.

| | |
|---|---|
| In land | $184,800 |
| In buildings | 43,200 |
| In machinery | 51,000 |
| Total | 279,000 |

### POWER.

| | |
|---|---|
| Number of boilers | 6 |
| Aggregate horse power | 140 |
| Number of steam engines | 6 |
| Animals | 54 |

### PRODUCT AND VALUE.

| | |
|---|---|
| Product in matte (short tons) | 1,151 |
| Total value of matte at the mines | $40,000 |

It will be seen from the foregoing that the mines of the United States furnished 1,151 short tons of matte, which was valued at $40,000 at the places where it was produced, which was in every case at the mine itself, without more than local transportation charges. This stage in the valuation is taken because it is desirable to show, under the items of labor and wages, the expenditures for working mines of the United States, and as soon as the product goes to the next stage it meets the heavy cost of refining to metallic nickel, which is a distinct industry apart from mining, and, moreover, at this stage the product of the United States mines loses its identity by mixture with the mattes from Sudbury, Canada. It will be seen at a glance that the cost of producing the matte bore no relation to the market value. This is principally because in the year 1889 large expenditures were made in development work, from which no sold product resulted, and this will go toward swelling the receipts of a later year, when the ores which the development work placed ready for commerce shall have passed through the smelter's hands into trade. Nevertheless, if the purely development work was excluded, the result would show a loss on the matte sold. This is because of the competition of the cheaper Sudbury matte, which makes the market price for matte. The fact that ores developed in work on the arsenide deposits of Nevada remained unsold leaves room for interesting speculation as to what might have been the result if these ores had been smelted. In this speculation it is a useful consideration that the regular mining work hitherto done has spasmodically developed irregular lots of ore rich beyond any comparison with the low-grade but steadily-produced ore of Lancaster Gap and even Sudbury, Canada, and such specimen mines do not with any regularity prove illusory when large-scale development and intelligent selection are brought to bear. On the other hand, it may also be remarked that these Nevada prospects have been investigated time and again during the past 10 years or more.

The metallic nickel produced from the matte given above, which constitutes the yield from ores of the United States, amounted to 217,663 pounds, accompanied as a by-product by 12,955 pounds of the pigment cobalt oxide. But in addition to this the nickel-refining works were concerned with a product of 35,000 pounds of nickel from the mattes of Canadian mines, making in all 252,663 pounds as the product of the nickel smelters of the United States, and worth as metallic nickel in New York or Philadelphia $151,598.

The impression has gone out that a small amount of platinum might also be obtained from the Canadian matte, but this does not seem to have been the case.

## OCCURRENCE.

The nickel deposits of the United States have frequently been described. Nickeliferous pyrrhotite occurs at many places, and particularly at Lancaster Gap, Pennsylvania, where the principal mining has been done for many years. It is also found with millerite at the Rabbit Foot mine in Saline county, Arkansas; in slight amount in the Black Hills in South Dakota, and has been reported from several localities in California. The silicate of nickel is found in narrow seams near Webster, North Carolina, and there seems to be a large area in that state in which a chrysolitic rock can be found, which is stained with oxidized nickel compounds. At Riddles station, Oregon, a deposit of nickel silicate has been found similar to that at Webster, North Carolina. The deposit is new, and little work has been done on it. It was not active in the census year. A third class of ores has been worked on for some years and is still the object of considerable attention in Churchill county, Nevada. Here several lodes containing the arsenides of nickel and cobalt have been opened. The ore seems to be unusually rich, though little is known as to its persistency. The deposits have been well described by Mr. C. A. Hitchcock in a letter to the Census Office, from which the following synopsis has been taken:

The nickel mines are located 41 miles east from Lovelock, a station on the Central Pacific railroad, in Cottonwood cañon, Table Mountain mining district, Churchill county. The cañon is on the east side of the range, and opens out into a wide valley. The country rock is slate, porphyry, and granite, covered in some places by porous limestone, which must have been deposited subsequent to the erosion of the cañon, as in many places it extends down to the stream at the bottom. About 5 miles down the cañon is a dike of iron ore, possibly 400 feet higher than the bed of the stream, and running nearly east and west. It extends about 1.5 miles in length. At short intervals this dike is crossed at varying angles by veins of a siliceous nature, which cut completely through the dike, and can be traced for some distance on either side, from 10 to 40 rods. Where these cross-veins intersect the iron dike is found the richest nickel and cobalt ores, and at these points most of the work of development upon the mines has been done.

Some openings have been made along the dike at other points than those mentioned, sufficient to demonstrate the presence of nickel. Also, these short cross-veins have been similarly prospected, and in almost every instance found to carry ore. Nearly all the vein matter in these mines carries ore, but along the foot and hanging walls and in pockets throughout the center of the veins occurs the high-grade ore, from 5 to 7 feet thick on the walls, and from a few pounds to 50 tons in the pockets, and occasionally the veins open into chimneys, which are invariably high-grade ores. The dike where it has been cut shows a width between walls of 48 feet, and the cross-veins vary from 10 feet to 50 feet in width at the intersections with the dike. The paying nickel ores are, as far as present discoveries have been made, confined to this limited locality, say 1.5 miles in length and one-fourth to one-half mile in width. Other discoveries have been made, but generally the ores are associated or combined with refractory matter and of a much lower grade.

About 30 locations have been made upon the dike and cross-veins, each being 1,500 by 600 feet, under the United States mining laws.

At the eastern end of the main dike the National Nickel Company has 2 claims, and upon the dumps are several hundred tons of ore, which are said to assay from 20 to 75 per cent of nickel. Several tunnels have been run into the hill under the iron capping following the ore, and only the ore cut by these tunnels has been removed from the mine. (*a*) About 100 perches west of the National Nickel Company's mines Mr. George Lovelock, sr., the discoverer of the mines, began work at a cross-vein on the location known as the Emperor in 1883. The work was continued until 1886, when the steam boiler gave out, and nothing has since been done except the assessment work required by the mining laws. At this point and at 2 other points on the adjoining claims to the west he took out and shipped 300 tons of ore of a high grade. He also set up a small 5-ton water-jacket furnace in 1885, and from this shipped matte to the amount of 34,000 pounds. The ore shipped by Mr. Lovelock assayed from 20 to 60 per cent nickel, and the matte which he shipped from the ore reduced assayed 36 per cent nickel and 34 per cent cobalt. The smelting of these ores was done in a very crude and unsatisfactory manner, by inexperienced and consequently incompetent hands. To this fact the dump testifies, for nickel melted from the ore can be found in globules from the size of a pea to the dimensions of a walnut all through the slag from the furnace. On the Emperor, at the point mentioned, 1 shaft has been sunk to the depth of 150 feet on the foot wall, cutting rich ore all the way down, and 1 shaft sunk to the depth of 50 feet on the hanging wall, also in the good ore. Both these shafts are now filled with water.

At the west end of the President, the adjoining claim, some ore was shipped, as also from the next claim west, the Empire. Both these claims show a good, strong vein. Upon a cross-vein near the President Mr. Kellogg has a claim, upon which an adit has been run about 150 feet. The ore from this tunnel is piled upon the dump. Several other claims are developed on a small scale, but no systematic mining has been done.

## FOREIGN NICKEL ORES.

CANADA.—By far the most important developments to be considered in connection with the ability of the United States to produce nickel are those in the neighborhood of Sudbury, Ontario. Here, in the oldest archæan rocks, large masses of pyrrhotite are found, containing nickel to the extent of 2.5 per cent, and sometimes more. The ore contains also chalcopyrite scattered through it, so that it yields about 5 to 7 per cent of copper. It was known as early as 1846, through a report to the Canadian government, that this was a promising region for copper ores, and it was for copper that the mines were first exploited. Mr. S. J. Ritchie, of Cleveland, Ohio, made application for a territory of about 100,000 acres, in an irregular territory about 25 miles long and from 3 to 7 miles wide. This was afterward considerably reduced. The Canadian Copper Company was organized in 1886 to develop this property, and has opened 3 mines, the Stobie, Evans, and Copper Cliff, each of which is typical of a distinct kind of deposit. Besides the property of the Canadian Copper Company, the Dominion Copper Company has opened the Blezard, Worthington, and Creau mines, and Sir H. H. Vivian owns the Murray mine, 2.5 miles northwest of Sudbury. The mines are well developed and are equipped with 2 water-jacketed furnaces belonging to the Canadian Copper Company, and one each to the other companies. The total yield of metallic nickel from the mattes from these mines aggregated 2,500,000 pounds in 1889, and 1,336,627 pounds in 1890, according to the division of mineral statistics of the Canadian geological survey. These Canadian mines have been fully described by Dr. E. D. Peters in the report of Mineral Resources of the United States and in volume XVIII of the Transactions of the American Institute of Mining Engineers.

NEW CALEDONIA.—The discovery near the close of the last decade that large quantities of nickel silicate exist in New Caledonia caused a sensation among nickel producers. It resulted in the formation of the well-known Société Anonyme le Nickel in Paris, and in the development of the mines which have since been the dominant supply of the world. The product of nickel was increased and the price depressed in the hope of a greater expansion in the consumption. This did not come, and the production was restricted. At present the mines are less influential than those in Canada, for although the ores are fully as rich, labor is not so good, and for imported laborers the climate is bad. The ores are found in V-shaped pockets in serpentine, which is found over two-thirds of the island. Many of the pockets are large, but narrow with the depth. The cost of mining is considerable, and the transportation facilities to the seacoast are poor. It is not probable that the mines can compete successfully with the Canadian. Lately manganiferous iron ores have been mined and shipped to Rouen for the purpose of extracting the oxide of cobalt, which they contain to the extent of 3 per cent, together with 2 per cent of nickel. This is doubtless for the purpose of securing a product with which nickel ores of Canada can not compete, as they do not contain a significant proportion of cobalt.

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[a] This information as to underground work was obtained through the courtesy of the superintendent, Mr. Charles Bell.

## PRODUCT OF NICKEL IN PREVIOUS YEARS.

The world's consumption of nickel has amounted annually to about 1,000 tons. New Caledonia has contributed the larger part in the last 10 years, displacing considerable amounts from Norwegian mines. The total amount produced in 1889 aggregated 2,000 short tons.

The product of the United States since 1876 has been as follows:

### PRODUCT OF THE UNITED STATES, 1876 TO 1889.

[Pounds.]

| YEARS. | Value. | Total. | Metallic nickel. | Nickel in matte. | Nickel in ore. | Nickel in nickel ammonium sulphate. |
|---|---|---|---|---|---|---|
| 1876 | $523, 554 | 201, 367 | | | | |
| 1877 | 301, 138 | 188, 211 | | | | |
| 1878 | 165, 979 | 150, 890 | | | | |
| 1879 | 162, 534 | 145, 120 | | | | |
| 1880 | 257, 282 | 233, 893 | | | | |
| 1881 | 292, 235 | 265, 668 | | | | |
| 1882 | 309, 777 | 281, 616 | 277, 034 | 4, 582 | | |
| 1883 | 52, 920 | 58, 800 | 6, 500 | 52, 300 | | |
| 1884 | 48, 412 | 64, 550 | | 64, 550 | | |
| 1885 | 179, 975 | 277, 904 | 245, 504 | 14, 400 | 18, 000 | |
| 1886 | 127, 157 | 214, 992 | 182, 345 | 20, 000 | 5, 600 | 7, 047 |
| 1887 | 133, 200 | 205, 566 | 183, 125 | 10, 846 | | 11, 595 |
| 1888 | 127, 632 | 204, 328 | 190, 637 | | 1, 000 | 12, 691 |
| 1889 | 151, 598 | 252, 663 | 209, 763 | 42, 900 | | |

In addition to the local product, the United States has always imported nickel. The imports have been as follows:

### NICKEL IMPORTED AND ENTERED FOR CONSUMPTION IN THE UNITED STATES, 1868 TO 1889, INCLUSIVE.

| YEARS ENDED— | Total value. | NICKEL. | | OXIDE AND ALLOY OF NICKEL WITH COPPER. | |
|---|---|---|---|---|---|
| | | Quantity. (Pounds.) | Value. | Quantity. (Pounds.) | Value. |
| June 30, 1868 | $118, 058 | | $118, 058 | | |
| 1869 | 134, 327 | | 134, 327 | | |
| 1870 | 99, 111 | | 99, 111 | | |
| 1871 | 52, 044 | 17, 701 | 48, 133 | 4, 438 | $3, 911 |
| 1872 | 27, 144 | 26, 140 | 27, 144 | | |
| 1873 | 4, 717 | 2, 842 | 4, 717 | | |
| 1874 | 5, 883 | 3, 172 | 5, 883 | | |
| 1875 | 3, 193 | 1, 255 | 3, 157 | 12 | 36 |
| 1876 | 10 | | | 156 | 10 |
| 1877 | 10, 346 | 5, 978 | 9, 522 | 716 | 824 |
| 1878 | 16, 654 | 7, 486 | 8, 837 | 8, 518 | 7, 847 |
| 1879 | 13, 399 | 10, 496 | 7, 829 | 8, 314 | 5, 570 |
| 1880 | 66, 069 | 38, 276 | 25, 758 | 61, 869 | 40, 311 |
| 1881 | 122, 130 | 17, 933 | 14, 503 | 135, 744 | 107, 627 |
| 1882 | 143, 660 | 22, 906 | 17, 924 | 177, 822 | 125, 736 |
| 1883 | 132, 484 | 19, 015 | 13, 098 | 161, 159 | 119, 386 |
| 1884 | 129, 733 | | | [a]194, 711 | 129, 733 |
| 1885 | 64, 166 | | | 105, 603 | 64, 166 |
| Dec. 31, 1886 | [b]141, 546 | | | 277, 112 | 141, 546 |
| 1887 | [c]205, 232 | | | 439, 037 | 205, 232 |
| 1888 | [d]138, 290 | | | 316, 895 | 138, 290 |
| 1889 | | | | | |

[a] Including metallic nickel.

[b] Including $465 worth of manufactured nickel.

[c] Including $879 worth of manufactured nickel.

[d] Including $2,281 worth of manufactured nickel.

The imports have been partly balanced by exports in the form of matte and speiss, as follows:

VALUE OF EXPORTS OF NICKEL AND NICKEL ORE OF DOMESTIC PRODUCTION FROM THE UNITED STATES.

| YEARS ENDED— | Manufactured nickel. | Nickel coin. | Nickel ore. |
|---|---|---|---|
| June 30, 1864 | | | $25,494 |
| 1865 | | | 36,710 |
| 1869 | | | 11,350 |
| 1872 | | | 43,500 |
| 1873 | $19,780 | | 19,891 |
| 1874 | 16,062 | | 75,696 |
| 1875 | 26,000 | | 72,020 |
| 1876 | 168,050 | | 35,100 |
| 1877 | 8,200 | | |
| 1878 | | | 2,452 |
| 1880 | 4,120 | | |
| 1881 | 6,600 | $32,880 | |
| 1882 | 12,474 | 7,200 | |
| 1883 | 9,911 | | *a*12,182 |
| 1884 | | | *a*22,249 |
| 1885 | 1,223 | | 10,500 |
| Dec. 31, 1886 | 45,653 | | 5,700 |
| 1887 | 39,209 | | 7,500 |
| 1888 | 38,951 | | 625 |
| 1889 | | | |

*a* Classed as "nickel and cobalt ore".

## USES.

In addition to the consumption for german silver, plating, and coinage, great efforts have been made to extend the use by the manufacture of rolled nickel plate and malleable nickel, and finally by adding a small percentage to steel. This last effort seems to have been successful. The report of Mr. James Riley to the British Iron and Steel Institute showed that an alloy of about 4 per cent of nickel in steel could be made with fairly even composition, and that the result was a general improvement of the steel, particularly in toughness and breaking strain. This was followed by several private tests of armor plates of this steel. In September, 1890, a board of ordnance officers of the United States navy, with Rear Admiral Kimberly as president, made a competitive test of 3 plates, 1 of the usual compound plates made by Messrs. Cammell & Co., Sheffield, 1 of steel, and 1 of steel containing about 3 per cent of nickel, both made by Messrs. Schneider & Co., of Creusot. The proving was conducted by Ensign R. B. Dashiell. "Each plate was attacked with 4 6-inch holtzer shells of 100 pounds weight and having a velocity of 2,075 foot-seconds, and 1 8-inch firming shell of 210 pounds weight and having a velocity of 1,850 foot-seconds, the points of impact being at the 4 corners for the 6-inch and at the center for the 8-inch shell. The compound plate was perforated by all the shells and practically destroyed by the 6-inch alone. The steel plate kept out all the shells, but was badly cracked by the 8-inch. The nickel plate kept out all the shells and remained without cracks." (*a*)

Congress was at once requested to appropriate (and did so) $1,000,000 for the purchase, at the discretion of the Navy department, of nickel ore. The report of the chief of the bureau of ordnance states that it may be confidently anticipated that nickel steel will enter into the composition of projectiles, both common and armor-piercing, of gun barrels for small arms, and later in the material used in the construction of artillery of large caliber.

This report has made a great impression and has resulted in active search for nickel ores, the strengthening of the producing concerns, and the establishment in this country of at least one concern for the manufacture of nickel steel.

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*a* Official report of the bureau of ordnance.

# ALUMINUM.

# ALUMINUM.

BY R. L. PACKARD.

## METALLURGICAL HISTORY.

Aluminum has been attracting an amount of attention during the last 2 or 3 years which is out of proportion to its actual (1890) importance as a metal and the position in the arts which it has hitherto occupied. This is accounted for by the comparatively recent appearance of the metal in commerce, the difficulty of extracting it, and the unfamiliar and elaborate metallurgical processes which have been invented in consequence. Some of these processes are reproductions on a large scale of experiments which are not ordinarily used even in chemical laboratories. A brief résumé of the history of these methods of extraction and their results will give a correct idea of the scope and merit of the industry.

In 1807 and 1808 Sir Humphrey Davy succeeded in obtaining the metals from the alkaline earths baryta, strontia, lime, and magnesia by electricity. His method was to place a paste of the respective earths on a strip of platinum connected with the positive pole of a powerful battery, put mercury in a small cavity in the paste, and connect it with the negative wire of the battery. Under the influence of the current the metallic oxide (the earth) was decomposed, an amalgam of the metal which it contained was formed, and the pure metal was obtained from this by distilling off the mercury. On applying this method to a paste made of alumina, Sir Humphrey Davy could not obtain the expected amalgam. He therefore varied the experiment in a way which is notable in view of certain recent methods, and which he described as follows:

> The first experiment by which I obtained evidence of its composition was made in 1808 by fusing iron negatively electrified in contact with it. The earth was moist in this process, and a very high voltaic power was applied. The globule of metal obtained was whiter than pure iron, effervesced slowly in water, becoming covered with a white powder, and the solution in muriatic acid decomposed by an alkali afforded alumina and oxide of iron.

He continues:

> By passing potassium in vapor through alumina heated to whiteness the greatest part of the potassium became converted into potassa, which formed a coherent mass with that part of the alumina not decompounded, and in this mass there were numerous gray particles having the metallic luster and which became white when heated in the air, and which slowly effervesced in water.—Works, 1840, volume IV, page 262.

Inconclusive as these experiments are as far as the separation of aluminum is concerned, they are interesting as the pioneers of the two lines of experiments, the electrical and chemical, each of which afterward led to the establishment of a commercial process.

The next step in advance was in the line of chemical experiment. Sir Humphrey Davy had failed to obtain aluminum from alumina, the oxide of the metal, by potassium vapor. Some 20 years later Wöhler, by substituting the chloride of aluminum for the oxide in this operation, succeeded in obtaining the metal, and was able to determine its physical properties.

In the account of his own works, published in 1827 (Poggendorf's Annalen, XI, page 147), Wöhler describes Oersted's experiments, made 3 years previously, and attributes to him the discovery of volatile aluminum chloride, which he prepared by the method, now well known in practice, of passing chlorine gas over a mixture of alumina and carbon heated to redness. By acting on the chloride so obtained with potassium amalgam Oersted stated that he had obtained an amalgam of aluminum, from which he had recovered the metal by distilling off the mercury. Wöhler repeated this experiment, but was unable to obtain aluminum, the metal remaining, after distilling off the mercury, being only potassium left over from the amalgam which had been used in the experiment. He did, however, succeed in reducing aluminum chloride by potassium itself, operating in porcelain crucibles. The aluminum was obtained in the form of a gray powder, and was not pure.

In 1845 Wöhler renewed his experiments (Poggendorf's Annalen, LXIV, 1845, pages 447–451), but in order to avoid the lively chemical reaction he varied the arrangement in such a way as to keep the aluminum chloride and potassium separate while the potassium was melted in the vapor of the chloride. This was accomplished in two ways: first, he introduced the chloride into a platinum tube, and then placed a platinum boat containing potassium in the tube near it. The tube was gradually heated to redness, when the chloride was volatilized and passed in vapor over the melted potassium, which decomposed the chloride and liberated the aluminum. He also placed the potassium in a small porcelain crucible, which was set in a larger one, and the space between was filled with the chloride. The whole was well covered and heated, when the reaction occurred. As before, the aluminum so obtained seemed to be in the form of a gray powder, but on closer inspection this powder was seen to be composed of tin-white metallic globules. Wöhler determined the specific gravity and other properties of these globules.

These laboratory experiments were resumed by H. Sainte-Claire Deville in France in 1854, who substituted sodium for potassium and operated on a larger scale than his predecessors. He placed aluminum chloride in considerable quantity in a glass tube, into which porcelain boats containing sodium were introduced, and the tube was then heated. The aluminum chloride was volatilized, and, coming in contact with the melted sodium, was decomposed thereby with a lively incandescence, forming chlorides of aluminum and sodium and setting free the aluminum, which was retained in the double chloride in a finely divided state. This mixture was then placed in boats made of retort carbon, which were highly heated in a porcelain tube, through which a current of dry hydrogen was passed. The double chloride was distilled off by this means, leaving the aluminum, which was afterward remelted and run into ingots. This was the method which Deville carried out on a large scale in 1855 in a furnace consisting of a retort for distilling the aluminum chloride, a chamber connected therewith containing iron nails to hold any ferric chloride which might distill over, and a third chamber beyond this containing trays of sodium. The inventor found much to improve in the details of the process, and by 1859 it had become modified so that the reduction was effected in a reverberatory furnace and fluor spar or cryolite was used as a flux. The double chloride of aluminum and sodium which was used in this operation was made by heating a mixture of alumina, carbon, and common salt in a retort and passing dry chlorine gas through it, on the principle introduced by Oersted, whereby the double chloride was distilled over and was caught in a receiver. Since that date many improvements have been made in the way of lessening the cost of the materials used in the process, especially in the manufacture of sodium by the Castner process in England, but the metallurgy remains substantially as it was when Deville established it. (Deville, de l'Aluminum, Paris, 1859.) This was the only process in practical operation in Europe down to 3 or 4 years ago. No serious attempt was ever made to introduce it into this country, because the limited uses and the high price of aluminum and its difficult metallurgy, which would be still more costly in this country than in Europe, where the refinements of chemical technology are more familiar than here, all conspired to repel investment in any large way.

The first step in advance in the electro-metallurgy of aluminum dates from the electrical decomposition of the fused double chloride of aluminum and sodium in 1854. The electrical decomposition of fused magnesium chloride by Professor Bunsen led to operating in a similar way on the fused double chloride of aluminum and sodium. Bunsen, in Germany, and Deville, in France, obtained metallic aluminum in this way, but no attempt was made to repeat the operation on an industrial scale until a much later date, when the introduction of modern dynamo-electric machines made it feasible.

The Siemens "electric furnace", patented in England in 1879, which was the forerunner of certain recent furnaces, may be regarded as a further advance toward the electro-metallurgy of aluminum. It consisted of a large crucible, connected with the poles from a dynamo and placed in a vessel filled with charcoal. The cathode passed through the bottom of the crucible, and was in contact with the metal to be melted by the heat of the current. The anode passed through a hole in the cover of the crucible, and the distance between the poles was ingeniously regulated by a solenoid. Iron, steel, and platinum were melted in this crucible. (English patent 2110 of 1879; Description of operation by dynamos, Ann. de chimie, sér. 5, tome 30, page 465.)

The intense heat which the electric current is capable of producing for metallurgical purposes was now known. It was also known that aluminum could be obtained by electrolysis, and the time was ripe for the industrial application of these facts as soon as dynamo electricity could be made available. Accordingly, in the last decade electro-metallurgical processes for obtaining aluminum have become favorite subjects for patents with inventors. It is sufficient to describe briefly the two which have been commercially successful in this country, and they will serve as types of all. The earlier of these, the Cowles process, was established in 1885, and is carried on by the Cowles Electric Smelting and Aluminum Company at Lockport, New York. It is at present (1890) confined to the production of aluminum alloys, viz, aluminum bronze (and brass) and ferro aluminum. This was the pioneer of such processes in the United States, and created an industry which has since been developed and extended. This process, which is now well known to persons interested in metallurgy, consists in passing the current from a powerful dynamo through a mixture of alumina (in the form of corundum, bauxite, etc.), carbon, and pieces of copper contained in a suitable vessel lined with carbon, through the ends of which vessel the large terminals of the dynamo are inserted. The mixture is arranged so as to prevent short circuiting. On passing the current the alumina is reduced in the presence of carbon and unites with the melted copper to form an alloy rich in aluminum. This alloy is afterward remelted, and enough copper added to it to reduce the aluminum contents to the proportions desired for aluminum alloys of the required grades.

The Cowles company has produced aluminum bronze as follows:

PRODUCT OF ALUMINUM BRONZE.

| YEARS. | Pounds. | Value. |
|---|---|---|
| 1885 | 4,000 to 5,000 | $1,600 to $2,000 |
| 1886 | 50,000 | 20,000 |
| 1887 | 144,764 | 57,000 |

Besides aluminum bronze, the Cowles company makes ferro-aluminum by the same process by which the bronze is made, substituting iron for copper. The alloy, containing from 5 to 10 per cent of aluminum, is used as a vehicle for introducing aluminum into molten iron. An idea of the growing demand for ferro aluminum for this metallurgical use is obtained from the statement of the Cowles company that they made in 1886 from 2,000 to 3,000 pounds, valued at from $780 to $1,170, and in 1887, 42,617 pounds, valued at $16,621. The total aluminum alloys produced in 1889 amounted to 171,759 pounds.

Many proposals have been made and many patents obtained for making alloys of aluminum with iron and sometimes with copper by reducing alumina with carbon in the presence of fluxes and the metals. Clay, kaolin, and other compounds of alumina, it is asserted, may be used for this purpose. Sometimes the iron or copper is added to the melted mixture used as a "bath", sometimes the mixture is added as a flux to iron in a cupola or similar furnace, and sometimes it is used as a paste on iron, which is then heated. The object in most cases is to make an iron aluminum alloy for "beneficiating" iron. The announcement of the good effect produced on iron by adding minute quantities of aluminum to it while melted and Mr. Keep's experiments on this subject have probably led inventors to patent processes of the above kind. It is to be regretted that these processes do not yet offer clear and certain evidence that they are distinct and decided improvements like the electrical processes, or, indeed, that they are operative in the manner described.

The Herault process, which, like the Cowles, makes aluminum alloys, had not been put into commercial operation in this country up to the close of the census year.

In the United States the extraction of aluminum itself is also effected by dynamo electricity, and is a new industry carried on by the Pittsburg Reduction Company at Pittsburg, Pennsylvania, operating under the patents of Mr. C. M. Hall. The process consists in forming a fused bath of the fluorides of aluminum, calcium, and sodium, to which calcium chloride is subsequently added, by melting a mixture of cryolite, aluminum fluoride, and fluor spar in a suitable vessel lined with carbon, adding alumina thereto, and then separating the aluminum by the current from a dynamo, the carbon electrodes of which dip into the bath. The process is continuous, because the alumina is renewed as it becomes exhausted. One merit of the process is that the fused bath is of less specific gravity than the aluminum set free, which therefore sinks to the bottom of the vessel. If alloys are desired, the negative electrode is formed of the metal which it is desired to alloy with aluminum. Variations in the composition of the bath are described in the different patent specifications, but that above given is believed to be the one used in practice. This company produced 19,200 pounds of aluminum in 1889, which was sold at $2 per pound in quantity. The total production of aluminum in the United States during 1889, including that contained in alloys, was 47,468 pounds, with a total value of $97,335.

Until the recent metallurgical use of aluminum in treating molten iron was introduced the metal was worked in this country in a small way, principally for parts of optical, engineering, and astronomical instruments, balance beams, light weights, and the like, where lightness and strength are desired. An idea of the extent of its use may be had from the following table of imports, which shows the amount of aluminum entered for consumption in the United States:

ALUMINUM IMPORTED INTO THE UNITED STATES.

| YEARS ENDED— | Quantity. (Pounds.) | Value. | YEARS ENDED— | Quantity. (Pounds.) | Value. |
|---|---|---|---|---|---|
| June 30, 1870 |  | $98.00 | June 30, 1880 | 340.75 | $4,042.00 |
| 1871 |  | 341.00 | 1881 | 517.10 | 6,071.00 |
| 1872 |  |  | 1882 | 566.50 | 6,495.00 |
| 1873 | *a*2.00 | 2.00 | 1883 | 426.25 | 5,079.00 |
| 1874 | *a*683.00 | 2,125.00 | 1884 | 595.00 | 8,416.00 |
| 1875 | *a*434.00 | 1,355.00 | 1885 | 439.00 | 4,736.00 |
| 1876 | 139.00 | 1,412.00 | 1886 | 452.10 | 5,369.00 |
| 1877 | 131.00 | 1,551.00 | Dec. 31, 1887 | 1,260.00 | 12,119.00 |
| 1878 | 251.00 | 2,978.00 | 1888 | 1,348.53 | 14,086.00 |
| 1879 | 284.44 | 3,423.00 | 1889 | 998.83 | 6,688.07 |

*a* Probably alloys.

## TOTAL PRODUCT OF ALUMINUM.

To conclude this review of the subject, it is a matter of curiosity to form an idea of the quantity of aluminum which has thus far been extracted. France was the only country which produced aluminum commercially until a few years ago. It had never been seen in any quantity until the Paris Exposition of 1855, where it was shown in ingots and in the form of manufactured articles of various kinds. Among ornamental articles it was noticed that a small body of the imperial guard wore breastplates of aluminum. The price of the metal was then 2,000 francs per kilogram. The production was as follows:

FRENCH PRODUCTION OF ALUMINUM IN 1863, 1867, AND 1872. (*a*)

| | TONNES. |
|---|---|
| 1863 | 1.0 |
| 1867 | 1.7 |
| 1872 | 1.8 |

*a* Paris Exposition, 1878, report of United States Commissioners, volume IV, page 184.

Aluminum was still somewhat of a curiosity in 1878, and was exhibited at the Paris Exposition in blocks, wire, sheets, and foil, and in the form of "objects, from a thimble and penholder to dinner sets of aluminum bronze and metal". (Ibid., page 84.) Telescopes, opera glasses, and other optical instruments, mounted wholly or in part in aluminum, and chemical balances made of the same metal, were shown, which were very light and strong.

Later statistics give the aluminum product for France as follows:

LATER ALUMINUM PRODUCT OF FRANCE.

| YEARS. | Amount. (Kilograms.) | Value. (Francs.) |
|---|---|---|
| 1886 | 2,430 | 243,000 |
| 1887 | 2,040 | 204,200 |
| 1888 | 2,955 | 295,500 |

These figures are taken from the official report published by the ministère des travaux publics, "Statistique de l'industrie minérale, etc., 1886-1888."

Allowing the French production to have been 1.5 tonnes a year from 1860 to 1880 and 2.5 tonnes from that date to 1889, inclusive, we should have 31.5+22.5=54 tonnes, or about 60 short tons, in the 30 years.

The Journal of the Society of Chemical Industry, July 31, 1890, page 781, gives the English production of aluminum as follows:

ENGLISH PRODUCTION OF ALUMINUM.

| YEARS. | Amount. (Pounds.) | Value at average market price in London. |
|---|---|---|
| 1888 | 5,000 | £5,000 |
| 1889 | 12,000 | 6,000 |

There was an English manufacture of aluminum from about 1860 to 1874, but no statistics of its production are obtainable. It could not have been very considerable, as the price of the metal was then very high. The Castner process was inaugurated in England in 1888. Supposing 5,000 pounds per annum to represent the English production from 1883, when the Webster process was put in operation, to 1888, we have 30,000 pounds, which, with the 12,000 pounds for 1889, equaling 42,000 pounds, or 21 tons, may be regarded as the English production up to the beginning of 1890. The French and English production together would therefore amount to about 82 tons. The Aluminum und Magnesium Fabrik, at Hemelingen, near Bremen, has been in operation since the latter part of 1887, and has supplied all the aluminum produced in Germany. The production of this company is given as follows:

PRODUCTION OF ALUMINUM BY THE ALUMINUM UND MAGNESIUM FABRIK.

| | KILOGRAMS. |
|---|---|
| 1887 | 1,700 |
| 1888 | 8,400 |
| 1889 | 9,500 |
| Total | 19,600 |

Adding this total to the figures representing the sum of the French, English, and the American production from all sources, exclusive of alloys, which is nearly 94 short tons, we get, in round numbers, 116 short tons, which therefore represents the total production of aluminum from 1860 to 1889, inclusive. This is an inconsiderable quantity of metal, but the indications are that the manufacture will be so largely increased from now on that this amount will soon be exceeded by the annual production.

## PHYSICAL PROPERTIES.

The tenacity of commercial aluminum is given by Mr. W. J. Keep as 18,866 pounds per square inch for a specimen, the probable composition of which was aluminum, 96.96 per cent; silicon, 0.59 per cent, and iron, 1.79 per cent. This was an average of 4 tests which were made by Mr. Theodore Stevens. The specific gravity of the metal was 2.66. Another series of tests of commercial aluminum containing 95.50 per cent aluminum, 1.62 per cent silicon, and 2.88 per cent iron gave 17,425 pounds per square inch tensile strength, the specific gravity being 2.72. (Transactions of the American Institute of Mining Engineers, Washington meeting, February, 1890.) On the other hand, tests made by Mr. W. H. Barlow give 26,800 pounds per square inch as the tensile strength, and tests of aluminum made by the Deville-Castner process give from 25,000 to 30,000 pounds. (Richards' Aluminum, 1890, pages 65, 66.)

The following table, taken from Professor Thurston's text-book on the Materials of Construction, gives the specific gravities and weights of 1 cubic foot of aluminum and several other commercial metals and alloys:

SPECIFIC GRAVITIES AND WEIGHTS OF ALUMINUM, ETC.

| SUBSTANCES. | Specific gravity. | Weight of 1 cubic foot. (Pounds.) |
|---|---|---|
| Aluminum, cast | 2.560 | 160 |
| Aluminum, sheet | 2.670 | 167 |
| Bronze (ordinary) | 8.400 | 524 |
| Copper, bolts | 8.850 | 584 |
| Copper, cast | 8.600 | 537 |
| Copper, sheet | 8.880 | 549 |
| Copper, wire | 8.880 | 550 |
| Iron, cast | from 6.955<br>to 7.295 | 435 to 456 |
| Iron, cast, average | 7.125 | 445 |
| Iron, wrought, average | 7.680 | 480 |
| Steel, hard | 7.820 | 496 |

The tensile strength and other properties of the Cowles aluminum bronze and brass are shown in the following table, taken from the official report of tests made under the direction of the engineer in chief of the navy at Watertown, Massachusetts:

TESTS MADE ON SPECIMENS OF ALUMINUM BRONZE AND BRASS.

| Mark or number. | APPROXIMATE COMPOSITION. | Length between reference marks. (Inches.) | Diameter. (Inches.) | Area. (Square inches.) | Tensile strength per square inch. (Pounds.) | Elastic limit per square inch. (Pounds.) | Elongation in 15 inches. (Per cent.) | Reduction of area. (Per cent.) | Diameter at fracture. (Inches.) | HARDNESS. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Head. | Stem. |
| 1 C | Cu 91.5, Al 7.75, Si 0.75 | 15 | 1.875 | 2.7612 | 60,700 | 18,000 | 23.20 | 30.70 | [a]1.56 | 9.39 | 13.85 |
| 7 C | Cu 88.66, Al 10, Si 1.33 | 15 | 1.875 | 2.7612 | 66,000 | 27,000 | 3.80 | 7.80 | [a]1.80 | 14.12 | 14.26 |
| 9 C | Cu 91.5, Al 7.75, Si 0.75 | 15 | 1.875 | 2.7612 | 67,600 | 24,000 | 13.00 | 21.62 | [a]1.66 | 11.18 | 13.59 |
| 10 C | Cu 90, Al 9, Si 1 | 15 | 1.875 | 2.7612 | 72,830 | 33,000 | 2.40 | 5.78 | [a]1.82 | ........ | ........ |
| 11 C | Cu 63, Zn 33.33, Al 3⅓, Si 0.33 | 15 | 1.875 | 2.7612 | 82,200 | 60–73,000 | 2.33 | 9.88 | [a]1.78 | 14.69 | 10.60 |
| 13 C | Cu 92, Al 7.5, Si 0.5 | 15 | 1.875 | 2.7612 | 59,100 | 19,000 | 15.10 | 3.59 | [a]1.64 | ........ | ........ |
| 9 D | Cu 91.5, Al 7.75, Si 0.75 | 15 | 1.900 | 2.8400 | 53,000 | 19,000 | 6.20 | 15.50 | [b]1.75 | ........ | ........ |
| 10 D | Cu 90, Al 9, Si 1 | 15 | 1.890 | 2.8100 | 69,930 | 33,000 | 1.33 | 3.30 | [b]1.86 | ........ | ........ |
| 11 D | Cu 63, Zn 33.33, Al 3.33, Si 0.33 | 15 | 1.900 | 2.8400 | 70,400 | 55,000 | 0.40 | 4.33 | [b]1.86 | ........ | ........ |
| 13 D | Cu 92, Al 7.5, Si 0.5 | 15 | 1.930 | 2.9300 | 46,550 | 17,000 | 7.80 | 19.19 | [b]1.73 | ........ | ........ |

[a] Chill castings.

[b] Dry sand castings.

Aluminum bronze is used for all purposes where strength and durability are required, and is furnished in all forms, such as large and small castings, ingots, billets, slabs, rods, sheets, bars, and wire. The propeller wheel for gunboat No. 2 of the United States navy was cast of this bronze.

For comparison, the following figures, showing the tensile strength of other bronzes and brasses and some kinds of iron and steel, are also taken from Thurston's text-book, referred to above. The strength of brasses varies greatly, the specimens tested being of different composition. The highest tensile strength given in the table from which these figures are taken is 52,928 pounds per square inch (composition, copper 79.65 per cent, zinc 20.35 per cent), and the lowest 1,568 pounds per square inch (composition, copper 29.17 per cent, zinc 70.83 per cent). Copper itself is given at 55,104 pounds. Bronzes range from 42,692 pounds per square inch (composition, copper 96.27 per cent, tin 3.73 per cent) down to 1,455 pounds per square inch (composition, copper 56.70 per cent, tin 43.17 per cent). Steel containing 0.53 per cent of carbon, other constituents not given, had a tensile strength of 79,062 pounds per square inch, while another specimen with 1.09 per cent carbon had a tensile strength of 116,394 pounds. The tensile strength of cast iron is given as follows:

| | POUNDS. |
|---|---|
| Good cast-iron pig, up to | 20,000 |
| Tough cast iron, up to | 25,000 |
| Hard cast iron, up to | 30,000 |

A comparison with the above figures will also give an idea of the place aluminum itself occupies in respect to tensile strength.

## SOURCES.

The principal sources of aluminum have hitherto been cryolite from Greenland and imported bauxite. The Greenland mine is at Evigtok, near Arksut. Previous to 1860 only small quantities of this cryolite were exported, but soon after that date the deposit was systematically worked, and cryolite was exported in considerable quantities. In recent years an American company, the Pennsylvania Salt Manufacturing Company, has imported several thousand tons annually. A writer in a New York journal describes the present appearance (1890) of the mine or quarry as "a hole in the ground, elliptical in shape, and, say, 450 feet long by 150 wide". The pit is 100 feet deep, and drills have penetrated 140 feet deeper and found cryolite all the way. This prospecting promises well for the future. The mine is close to the water's edge in Arksut fjord, and the ships of the American company's fleet visit the place every season and load directly from the "stock pile" of the mine.

The increased demand for alumina-bearing materials has called attention to American deposits of bauxite and "alum beds". Bauxite has been found in several places in Floyd county, Georgia. A notice of the mineral as far as known in 1887, at which time the deposit had not been opened to any extent, was published by Mr. Edward Nichols in the Transactions of the American Institute of Mining Engineers, volume XVI (1888), page 905. The analyses were as follows:

ANALYSES OF BAUXITE FROM FLOYD COUNTY, GEORGIA.

| COMPONENT PARTS. | No. 1. (Per cent.) | No. 2. (Per cent.) | No. 3. (Per cent.) |
|---|---|---|---|
| Silica | 2.80 | | 2.300 |
| Alumina | 52.21 | 57.25 | 56.880 |
| Iron oxide ($Fe_2O_3$) | 13.50 | 3.21 | 1.490 |
| Titanic acid ($TiO_2$) | 3.52 | 3.60 | 3.550 |
| Water | 27.72 | | |
| Phosphoric acid ($P_2O_5$) | | | 0.066 |

No. 1 was a dark-colored specimen; Nos. 2 and 3, light-colored specimens.

The most recent discoveries of bauxite are in Saline and Pulaski counties, Arkansas. Dr. J. C. Branner, the state geologist, has made a report on the subject to the governor of that state, from which the following information is condensed.

The mineral or ore occurs in Arkansas only in tertiary areas and in the neighborhood of granites. It appears in irregular deposits, whose thickness and extent are determinable only by direct methods of examination. The Arkansas bauxite beds are known to cover a total area of about 640 acres in Saline and Pulaski counties. A sample from the Little Rock region analyzed as follows:

ANALYSES OF BAUXITE FROM PULASKI COUNTY, ARKANSAS.

| COMPONENT PARTS. | No. 1. (Per cent.) | No. 2. (Per cent.) |
|---|---|---|
| Silica | 10.13 | 11.48 |
| Alumina | 55.59 | 57.62 |
| Iron (ferric) oxide | 6.08 | 1.83 |
| Water | 28.99 | 28.63 |
| Total | 100.79 | 99.56 |

ANALYSES OF BAUXITE FROM SALINE COUNTY, ARKANSAS.

| COMPONENT PARTS. | Black variety. (Per cent.) | Red variety, No. 1. (Per cent.) | Red variety, No. 2. (Per cent.) |
|---|---|---|---|
| Silica | 5.11 | 4.89 | 3.34 |
| Alumina | 55.89 | 46.44 | 58.60 |
| Iron (ferric) oxide | 19.45 | 22.15 | 9.11 |
| Water | 17.39 | 26.68 | 28.63 |
| Total | 97.84 | 100.16 | 99.68 |

Many localities are mentioned where the deposits crop out in the area specified.

Besides bauxite, kaolin is mentioned in this report as occurring in Pike, Pulaski, Saline, and Ouachita counties. The composition of the Pike county kaolin is as follows:

ANALYSIS OF KAOLIN FROM PIKE COUNTY, ARKANSAS.

| | PER CENT. |
|---|---|
| Silica | 48.87 |
| Alumina | 36.54 |
| Iron (ferric) oxide | 0.98 |
| Lime | 0.19 |
| Magnesia | 0.25 |
| Water | 13.29 |
| Total | 100.12 |

That from Pulaski county is described as either modified bauxite or decayed granite, as follows:

ANALYSIS OF KAOLIN FROM PULASKI COUNTY, ARKANSAS.

| | PER CENT. |
|---|---|
| Silica | 46.27 |
| Alumina | 38.57 |
| Iron (ferric) oxide | 1.36 |
| Lime | 0.34 |
| Magnesia | 0.25 |
| Potash | 0.23 |
| Soda | 0.37 |
| Water | 13.61 |
| Total | 101.00 |

The Ouachita kaolin resembles a sandy clay, and its true nature would hardly be suspected from its general appearance. If the sand is washed out and the material analyzed it is found to have the same composition as some of the best kaolins. In the following table is an analysis of Ouachita county kaolin after removing the greater part of the sand. An analysis of a Pennsylvania kaolin from Brandywine Summit is given for comparison.

COMPARATIVE ANALYSES OF KAOLIN FROM ARKANSAS AND PENNSYLVANIA.

| COMPONENT PARTS. | Ouachita county. (Per cent.) | Pennsylvania. (Per cent.) |
|---|---|---|
| Silica | 48.62 | 47.24 |
| Alumina | 36.52 | 37.27 |
| Iron (ferric) oxide | 1.74 | 1.94 |
| Water | 13.40 | 13.62 |
| Total | 100.28 | 100.07 |

"Alum beds" have been found in Purgatory valley, about 12 miles east of Trinidad, Colorado, and some assessment work has been done there in locating claims and opening up the deposits. 2 deposits of a similar material have also been found on the Gila river, in New Mexico, 1 of which is some 20 miles from Silver City. It is said to be extensive, and many claims have been taken up and some prospecting work done. The other deposit is on the southern Gila, and fluor spar has been found in the neighborhood. Professor Huntington, of Silver City, from whom this information was obtained, forwarded a specimen from the deposit near Silver City, and an analysis shows the following results:

| | PER CENT. | |
|---|---|---|
| Alumina ($Al_2O_3$) | 12.75 | |
| Sulphuric acid ($SO_3$) | 30.79 | |
| Lime ($CaO$) | 0.32 | |
| Magnesia ($MgO$) | 0.79 | |
| Water ($H_2O$) | 41.35 | |
| Total soluble in water | | 86.00 |
| Silica ($SiO_2$) | 7.97 | |
| Alumina and a little oxide of iron ($Al_2O_3+Fe_2O_3$) | 5.22 | |
| Lime ($CaO$) | 0.27 | |
| Undetermined | 0.26 | |
| Total insoluble in water | | 13.72 |
| | | 99.72 |

The alumina is present as a sulphate, which easily dissolves in water.

On calculating the alumina, the sulphuric acid corresponding to it, and water to 100 per cent, neglecting the lime and magnesia, the result is as follows:

| | PER CENT. |
|---|---|
| Alumina ($Al_2O_3$) | 15.16 |
| Sulphuric acid ($SO_3$) | 35.67 |
| Water ($H_2O$) | 49.17 |
| Total | 100.00 |

which is the composition of alunogen.

# MANGANESE.

# MANGANESE.

BY JOSEPH D. WEEKS.

## THE ORES OF MANGANESE.

The commercial ores of manganese are almost universally oxides. At two locations, one in Merionethshire, in Wales, the other at Chevron, in Belgium, a carbonate is mined. The common ores of manganese, known as psilomelane, pyrolusite, braunite, and wad, are all oxides.

Three oxides of commercial importance are noted:

**PROTOXIDE** ($MnO$), known also as the monoxide or manganous oxide. Multiplying the amount of the protoxide or $MnO$ in an ore by 0.7746 will give the contents of metallic manganese in the ore.

**SESQUIOXIDE** ($Mn_2O_3$), brown oxide, known also as manganic oxide. This oxide occurs in nature as braunite and in the state of hydrate as manganite ($Mn_2O_3$, $H_2O$). Multiplying the amount of sesquioxide ($Mn_2O_3$) in an ore by 0.6392 will give the amount of metallic manganese in the ore.

**PEROXIDE** ($MnO_2$). Multiplying the amount of peroxide ($MnO_2$) in an ore by 0.63218 will give the amount of metallic manganese in the ore.

The common ores of manganese are as follows:

**HAUSMANNITE** is a form of the brown oxide, containing theoretically 72.1 per cent of metallic manganese.

**PYROLUSITE**, or binoxide, or black oxide of manganese is the most common of its ores used commercially, and is the peroxide. This is the name properly applied to the iron-black or shining dark steel-gray crystals. It generally occurs in minute crystals, grouped together and radiating from a common center. It is this variety that is chiefly used by glass makers, as in its crystallized form manganese ore contains the least iron.

**PSILOMELANE**, an impure peroxide or black oxide, allied to wad by containing water, is one of the most generally diffused of the ores of manganese. It is compact and fibrous, and has a dark steel-gray color and submetallic luster. It generally occurs in botryoidal or grapelike masses.

**BRAUNITE** is the brown or sesquioxide. It occurs massive and also crystallized. It is distinguished by its brownish color. It is one of the most common ores in the United States.

**WAD** is a hydrated peroxide or black oxide. It is not used at all in the United States. It sometimes occurs as a hard and compact ore, though usually in brownish-black masses loosely agglomerated.

There is a most intimate connection between the ores of iron and those of manganese, so intimate as to lead to manganese being at first regarded as an ore of iron. Its origin is evidently similiar to iron, and its distribution is almost coextensive with the deposits of the brown hematite ores of this country. In almost all of these iron ores manganese occurs as a constituent. Sometimes the manganese displaces so much of the iron as to make the ore a manganiferous iron ore.

In close proximity to certain of the silver ores of the west, especially the carbonates of Leadville, iron and manganese ores carrying a percentage of silver are found. These ores, which have been termed manganiferous silver ores, are from the upper workings of Leadville, and carry manganese in varying quantities from 5 up to 25 per cent, and occasionally 30 to 35 per cent, with 5 to 20 ounces of silver, 0 to 4 per cent of lead, 7 to 18 per cent of silica, and 30 to 50 per cent of iron.

It should also be noted that the zinc ores of Sussex county, New Jersey, which are mined for zinc, contain considerable manganese. These zinc ores are a mixture of willemite, franklinite, zincite, and calcite. The residuum from working these ores for zinc, which may be termed manganiferous zinc ores, is used in blast furnaces in New Jersey and in eastern Pennsylvania for the manufacture of spiegeleisen.

The ores of manganese, or those carrying manganese, will be divided into 4 general classes: first, manganese ores; second, manganiferous iron ores; third, manganiferous silver ores, and fourth, manganiferous zinc ores. The dividing line between the first two grades is taken at 70 per cent binoxide of manganese, equal to 44.25 per cent metallic manganese, this being the standard of shipments to English chemical works. All ores containing at least this amount of manganese are classed as manganese ores; those containing a less percentage of manganese and containing also more or less iron are classed as manganiferous iron ore. In the third class are included the manganiferous silver ores of Colorado, which are utilized chiefly for the silver they contain. They have an added value, however, by reason of the fluxing qualities imparted to them by the presence of manganese and iron. In the fourth class is placed the residuum or clinker from the zinc ores of New Jersey.

The ton used in this report is the long ton of 2,240 pounds if not otherwise designated.

## MINING LOCALITIES IN THE UNITED STATES.

By far the larger proportion of the manganese ores proper produced in the United States is mined in 3 localities: Crimora (Virginia), Cartersville (Georgia), and Batesville (Arkansas).

Of the 24,197 tons of manganese produced in the census year, 20,325 tons were from these 3 districts. Manganese is found, however, in many places in the United States. For example, all along the western slope of the eastern ridge of the Appalachian range from Maine to Georgia more or less manganese has been mined. There is also some manganese ore found associated with the hematite ores of the Lake Superior region, and in Arkansas southwest from Batesville. With few exceptions, however, the deposits are small, and the indications are not such as to justify the expenditure of large amounts of money in mining and washing plants, which are usually necessary in the economical production of manganese. From one locality in Vermont, however, as will be seen by the report, considerable manganese has been produced, and there are mines in Virginia along the Shenandoah valley and its southern extension, as well as on the upper James, at which some manganese was produced in 1890, and which it is believed will add largely to its production in this country in the near future. A similar statement can be made of mines in Georgia.

The largest proportion of the manganiferous iron ores produced in the United States are from the Lake Superior region, and chiefly from the Gogebic district of Wisconsin and Michigan, where it is found associated with the iron ores of that section. Some manganiferous iron ore is mined in Virginia with manganese ores, but all the ore mined in that state in 1889 is classed as manganese. In Colorado quite an amount of manganiferous iron ore, in addition to the manganiferous silver ore, was produced in 1889 and used at Pueblo and at Chicago in the manufacture of spiegeleisen. All of this was from the Leadville district.

Most of the manganiferous silver ore mined in 1889 was from the Leadville district of Colorado.

All of the manganiferous zinc ores were from Sussex county, New Jersey.

## PRODUCTION OF MANGANESE ORES.

In the following table will be found a statement of the production of manganese ores in the United States in 1889; also a statement as to its total value, the average value per ton, the number of employés, total wages of such employés, total capital, and the division of these items by states:

PRODUCTION OF MANGANESE ORES IN THE UNITED STATES IN 1889.

| STATES. | Production. (Tons.) | Total value. | Value per ton. | Number of employés. | Total wages paid. | CAPITAL INVESTED. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Total. | In land. | In buildings and fixtures. | In tools, live stock, machinery, and supplies on hand. | All other items, including cash. |
| Total | 24,197 | $240,559 | $9.94 | 432 | $123,958 | $2,188,950 | $1,618,650 | $98,700 | $233,750 | $237,850 |
| Arkansas | 2,528 | 23,173 | 9.17 | 96 | 33,191 | 1,215,000 | 1,100,900 | 38,500 | 35,600 | 40,000 |
| California | 53 | 901 | 17.00 | 10 | 1,149 | 2,400 | 2,000 | 400 | | |
| Georgia | 5,208 | 50,143 | 9.63 | 117 | 19,486 | 247,350 | 163,250 | 32,800 | 21,900 | 29,400 |
| Nevada | 15 | 83 | 5.53 | 2 | 53 | 600 | | | | 600 |
| North Carolina | 47 | 470 | 10.00 | 2 | 160 | 250 | | | | 250 |
| South Carolina | 124 | 744 | 6.00 | 6 | 400 | 5,000 | 2,500 | 750 | 250 | 1,500 |
| Tennessee | 30 | 120 | 4.00 | 3 | 70 | 100 | | | | 100 |
| Vermont | 1,576 | 8,668 | 5.50 | 25 | 3,510 | 7,250 | | 1,250 | 1,000 | 5,000 |
| Virginia | 14,616 | 156,257 | 10.69 | 171 | 65,939 | 711,000 | 350,000 | 25,000 | 175,000 | 161,000 |

In the preceding table is included a very small amount of ore which, under strict classification, would be regarded as manganiferous iron ores, but as the metallic manganese in but few cases falls below 40 per cent they are all reported as manganese ores. Less than 1,000 tons of ore fall below 44.25 per cent of metallic manganese, and the average of the whole 24,197 tons is above this percentage.

Certain explanations of these statistics are necessary to prevent wrong deductions or conclusions. In but four instances, at the most, is manganese-ore mining prosecuted in the United States with anything like regularity, and in but two of the four was mining continuous. At the works producing the largest amount of manganese in Georgia the mines were operated but 190 days in the year, while at the Vermont mine during a large proportion of the year but little work was done. At 1 mine in Virginia and 1 in Arkansas the mining of manganese is fairly continuous. At most of the other works the production reported has been from very irregular workings, and chiefly for the purpose of testing the character of the deposit. This is true of all the production of Tennessee, North Carolina, South Carolina, and Nevada, while the California production is from an old mine, worked occasionally to meet a small demand for manganese for the purpose of making chlorine gas in working sulphuret ores.

It will be judged from this statement, therefore, that the reports in the table as to the number of employés and wages paid simply refer in most cases to men who were employed for a very brief time, and who were in most instances common laborers picked up from farm and other work, returning to their ordinary occupations as soon as their temporary services in stripping manganese-ore deposits and in mining the small quantities of manganese reported were completed.

The item of capital includes not only the money actually invested in works, but also the value of the mine or mineral right. In some cases a high valuation is placed upon these rights. Future developments will be necessary to determine whether it is too high.

From the preceding table of the production of manganese it will be seen that 60.4 per cent of the manganese produced in the United States was from the mines of Virginia. Of this production 12,974 tons were from the well-known Crimora mine and the opening adjoining it, known as the Old Dominion mine. More manganese has been taken from these mines, which are practically the same deposit, than from all the rest of the United States, and it is probably fair to say that this deposit has produced more than any other mine in the world. The grade of the ore is somewhat above the limit dividing manganese and manganiferous iron ore, the average shipments for 1889 showing 46 per cent metallic manganese.

Georgia stands second in point of production. Of the 5,208 tons produced in this state in 1889 over 4,000 tons were from the mines of 1 company.

Arkansas stands third in point of production, and here again by far the larger proportion of the ore produced was from 1 mine. The fourth state in point of production of manganese was Vermont, 1,336 tons being produced from 1 mine. As is noted above, the production of manganese in other states has chiefly been in an experimental way.

## PRODUCTION OF MANGANIFEROUS IRON ORES.

A large proportion of the hematite iron ores of the United States carry more or less manganese. While in most cases the amount of manganese in these ores does not increase their value over what the same ores would be worth as iron ores were the manganese absent, they, however, make the ore more desirable for certain purposes. No attempt has been made to collect the statistics of these manganese-bearing iron ores except in cases where the manganese in them has added somewhat to their value.

A product of 31,341 tons of ore, containing on an average 9 per cent of manganese, is reported from Michigan, and a further product of 50,018 tons of ore, containing 6.74 per cent of manganese, is reported for the same state, making a total of 81,359 tons of iron ore produced in Michigan containing sufficient manganese to make it desirable to be mined. The value of this ore is reported at $3.25 per ton.

In Colorado 2,075 tons of manganiferous iron ores, used in the manufacture of spiegeleisen, were produced in 1889. This was valued at $3.50 per ton.

The total production of manganiferous iron ores in the United States in 1889 was as follows:

PRODUCTION OF MANGANIFEROUS IRON ORES IN THE UNITED STATES IN 1889.

| STATES. | Production. (Tons.) | Total value. | Value per ton. |
|---|---|---|---|
| Total | 83, 434 | $271, 680 | $3. 26 |
| Michigan, containing 9 per cent of manganese and over | 31, 341 | 101, 858 | 3. 25 |
| Michigan, containing 6.74 per cent of manganese | 50, 018 | 162, 559 | 3. 25 |
| Colorado, containing 20 per cent of manganese and over | 2, 075 | 7, 263 | 3. 50 |

It is impossible to give any statement as to the number of employés, amount of wages, or capital invested in the production of this ore, as these items are included in the report on the iron-ore or silver production of the mines supplying it.

## PRODUCTION OF MANGANIFEROUS SILVER ORES.

The only district producing manganiferous silver ores in 1889 was Leadville, Colorado. It has been estimated that from 300 to 500 tons of this ore are produced per day. On the basis of the lowest figures, that is, 300 tons a day for 300 days in the year, the production of manganiferous silver ore in the Leadville district would be 90,000 tons. The actual statements received show a product of 64,987 tons, of an average value of $3.50.

PRODUCT OF MANGANIFEROUS SILVER ORES IN THE UNITED STATES IN 1889.

| | |
|---|---|
| Colorado 20 per cent of manganese and over (tons) | 9,987 |
| less than 20 per cent of manganese (tons) | 55,000 |
| Total (tons) | 64,987 |
| Total value | $227,455.00 |
| Value per ton | 3.50 |

## MANGANIFEROUS ZINC ORES.

In Sussex county, New Jersey, a zinc ore carrying considerable percentage of manganese is produced. This ore is first utilized for its zinc; the residuum, or clinker, as it is called, is then used in the production of spiegeleisen, the first spiegel made in the United States (in 1870) having been produced from these ores. The production of this manganiferous zinc residuum (or, better, the amount used in the production of spiegel) in 1889 was 43,648 tons, valued at $1.25 per ton, containing on an average about 11 per cent of manganese and producing 14,124 tons of spiegeleisen.

Owing to the fact that this manganiferous zinc ore is simply a residuum or by-product in zinc smelting, it is impossible to give any other statistics concerning it than the simple tonnage produced and the value of the same at the zinc furnaces. The capital invested, the number of employés, and the wages paid in the production of this clinker are given in connection with the report on the production of metallic zinc.

## PRODUCTION AND VALUE OF ALL CLASSES OF MANGANESE ORES MINED IN THE UNITED STATES IN 1889.

In the following table are grouped the statements showing the total production and value of all classes of manganese ores mined in the United States in 1889. The manganiferous iron ores mined in the Lake Superior district and those mined in Colorado will also be reported upon in the iron-ore report. The manganiferous silver ores will be mentioned also in the report on silver ores, though as the manganese contained is much larger in percentage than the silver, they are spoken of as manganese or manganiferous ores, and not silver ores.

TOTAL PRODUCTION AND VALUE OF ALL CLASSES OF MANGANESE ORES MINED IN THE UNITED STATES IN 1889.

[Tons.]

| CLASSES OF ORES. | Production. (Tons.) | Total value. | Value per ton. |
|---|---|---|---|
| Total | 216,266 | $794,254 | $3.67 |
| Manganese ores | 24,197 | 240,559 | 9.94 |
| Manganiferous iron ores | 83,434 | 271,680 | 3.26 |
| Manganiferous silver ores | 64,987 | 227,455 | 3.50 |
| Manganiferous zinc ores | 43,648 | 54,560 | 1.25 |

## PRODUCTION OF MANGANESE ORES IN THE UNITED STATES SINCE 1880.

The production of manganese from 1880 to 1889, inclusive, was as follows:

PRODUCTION OF MANGANESE ORES IN THE UNITED STATES.

[Tons.]

| STATES. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. | 1886. | 1887. | 1888. | 1889. |
|---|---|---|---|---|---|---|---|---|---|---|
| Total | 5,761 | 4,895 | 4,532 | 6,155 | 10,180 | 23,258 | 30,193 | 34,524 | 29,198 | 24,197 |
| Virginia | 3,661 | 3,295 | 2,982 | 5,355 | 8,980 | 18,745 | 20,567 | 19,835 | 17,646 | 14,616 |
| Arkansas | | 100 | 175 | 400 | 800 | 1,483 | 3,316 | 5,651 | 4,312 | 2,528 |
| Georgia | 1,800 | 1,200 | 1,000 | | | 2,580 | 6,041 | 9,024 | 5,568 | 5,208 |
| Other states | 300 | 300 | 375 | 400 | 400 | 450 | 269 | 14 | 1,672 | 1,845 |

The preceding table shows the production of what may be strictly regarded as manganese ores in the classification before given. It has been impossible in some cases to separate the manganese and manganiferous ores which are the product of a given mine, but where the total production of state or mine averages more than 44.25 per cent of metallic manganese its production is regarded as manganese ores.

The data necessary to show the production of all classes of manganese ores do not go farther back than 1880.

## THE WORLD'S PRODUCTION OF MANGANESE IN 1888 AND 1889.

The following statement from Messrs. Macqueen Bros., of London, the largest dealers in manganese in the world, shows the imports of high-grade manganese, that is, manganese ore containing from 45 to 55 per cent of metallic manganese, into European countries in 1888 and 1889:

IMPORT AND EXPORT MOVEMENTS OF MANGANESE ORE IN 1888 AND 1889.

[Tons.]

| COUNTRIES. | 1888. | 1889. |
|---|---|---|
| Imported into— | | |
| Great Britain | 74,906 | 99,062 |
| France | 6,174 | 4,584 |
| Belgium | 1,945 | 3,125 |
| Germany | 9,624 | 12,431 |
| Total | 92,649 | 119,202 |
| Exported from— | | |
| Caucasus (Russia) | 48,653 | 55,383 |
| Chile | 24,746 | 25,915 |
| Spain | 2,830 | 17,241 |
| Portugal | 5,638 | |
| Turkey | 669 | 8,329 |
| Greece | 500 | |
| Italy | 385 | ........ |
| Sweden | 6,089 | 8,320 |
| Australia | 1,572 | 2,284 |
| New Zealand | 787 | |
| Canada | 248 | ........ |
| Austria | ........ | 1,247 |
| Other countries | 532 | 483 |
| Total | 92,649 | 119,202 |

To arrive at the world's product there should be added to the above the product of the United States, Great Britain, France, Belgium, Germany, Cuba, and the Canadian ore that comes to the United States. Taking the latest available figures of production, and where these figures are not for 1888 or 1889 regarding them as approximately the product of that year, the following is the estimated total product of manganese in the world in 1888 and 1889:

TOTAL PRODUCT OF MANGANESE IN THE WORLD IN 1888 AND 1889.

[Tons.]

| COUNTRIES. | 1888. | 1889. | COUNTRIES. | 1888. | 1889. |
|---|---|---|---|---|---|
| Caucasus (Russia) | 48,653 | 60,000 | Greece | 385 | 400 |
| United States | 29,198 | 24,197 | Italy | 1,652 | 400 |
| Chile | 24,746 | 5,000 | Cuba | 1,581 | 4,000 |
| France (1886) | 7,676 | ........ | Other countries | 3,114 | 1,000 |
| Sweden | 6,089 | 18,000 | Nova Scotia | 106 | 200 |
| Portugal | 5,638 | | New Brunswick | 1,094 | 1,000 |
| Spain | 2,830 | | Quebec | 3 | ........ |
| Australia | 1,572 | 9,000 | Great Britain (1887) | 13,054 | 10,000 |
| New Zealand | 787 | ........ | Bosnia | 4,000 | 2,000 |
| Turkey | 669 | 8,000 | Holland | 1,107 | 800 |

## PRODUCTION BY STATES.

### ALABAMA.

No manganese nor manganiferous iron ores were mined in Alabama in 1889. In the brown hematite iron ore beds of this state, as in similar deposits in other localities in the Appalachian region, a manganiferous iron ore is often found. As early as 1875 one of these deposits of ore was utilized by the Woodstock Iron Company, of Anniston, Calhoun county, in the manufacture of spiegeleisen. The ores in the neighborhood of Woodstock occur, as is stated, as a constituent of iron ore, sometimes as veins and crusts resting upon the iron ore, at others in chimneys or pockets in the ore belt or vein. These crusts vary in thickness from 1 to 3 feet. Analyses of such a deposit are given on the following page.

### ANALYSES OF MANGANIFEROUS BROWN HEMATITE IRON ORE NEAR WOODSTOCK, ALABAMA.

| COMPONENT PARTS. | No. 1. | No. 2. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Metallic iron | 38.50 | 41.76 |
| Metallic manganese | 11.44 | 13.68 |
| Silica | 11.45 | 24.65 |
| Phosphorus | 0.27 | 0.55 |
| Combined water | 11.62 | 10.66 |

As a rule, in mining iron ore no attempt is made to separate the manganiferous portions, but both grades are charged into the furnace together. The proportion of manganese in the charge is small, but sufficient to give the cinder the greenish tinge indicative of its presence.

In a paper read before the American Institute of Mining Engineers on the geology of Alabama by Mr. E. J. Schmitz, of New York, the following analyses of manganese ores from this state are given. It is evident that these ores can not exist in any quantities or certainly some use would have been made of them, rich as the analyses show them to be.

### ANALYSES OF MANGANESE ORES FROM ALABAMA.

| No. | VARIETIES. | Formation. | County. | Analyst. | Per cent of peroxide of manganese. | Specific gravity. |
|---|---|---|---|---|---|---|
| 1 | Pyrolusite | Metamorphic | Chilton | Endemann | 71.22 | |
| 2 | Psilomelane | Silurian | Talladega | Mallet | 62.43 | 3.712 |
| 3 | Psilomelane | Metamorphic | Randolph | Mallet | 63.25 | 3.988 |

The only ore shipped from this state was from Stocks Mills, in Cherokee county, late in 1886, by Messrs. Kelly & Webb. Their operations showed the existence of a series of small pockets yielding ore quite low in phosphorus, analyzing about 45 per cent of manganese, 0.08 per cent of phosphorus, 5 per cent of iron, and 8 per cent of silica. Only about 75 tons were mined.

The ore at the furnace of the Woodstock Iron Company at Anniston is stated by Professor William P. Blake to have contained about 20 per cent of metallic manganese and no phosphorus. Professor Blake's analyses of the spiegeleisen made at this furnace from December 10, 1875, to February 3, 1876, are as follows:

### ANALYSES OF SPIEGELEISEN MADE IN ALABAMA.

| COMPONENT PARTS. | December 10. | January 6. | February 1. | February 3. |
|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Iron | 85.11 | 85.98 | 80.37 | 73.86 |
| Carbon | 3.66 | 4.83 | 4.94 | 4.32 |
| Silica | 0.95 | 0.88 | 0.38 | 0.93 |
| Phosphorus | 0.10 | 0.17 | 0.18 | 0.18 |
| Manganese | 10.18 | 8.14 | 14.13 | 20.69 |

## ARKANSAS. (*a*)

Manganese ores are found in 2 localities in Arkansas, 1 known as the Batesville region, chiefly in Independence and Izard counties, in the northeastern part of the state, and the other in the southwestern part of the state, extending from Pulaski county on the east to Polk county and Indian territory on the west. But little work has been done in the southwestern district, and that principally in the way of development. The Batesville or northeastern district has furnished all of the ore produced commercially in Arkansas.

The existence of manganese in the Batesville region has been known for over 40 years, but it is only since 1881 that it has been mined on a commercial scale. Colonel Matthew Martin mined and shipped small quantities of these ores to Boston, New York, and Philadelphia as early as 1850 to 1852. One shipment is said to have been made to Liverpool, where it was used in Tennant's Glasgow chlorine works. As there were no railroads in the country at that time, the ore was hauled in wagons to the White or Black river, whence it was shipped by barges to New Orleans, and then transferred for Liverpool.

Though shipments were made thus early, a few hundred tons would probably include the total quantity produced up to 1868. In that year Mr. William Rinstein, of Saint Louis, made the first shipment of manganese

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*a* In volume I of the annual report of the geological survey of Arkansas for 1890 will be found a very complete and detailed description of the occurrence of manganese ores in Arkansas, by Dr. R. A. F. Penrose, jr.

from Arkansas for steel purposes. This was sent to Messrs. Schoenberger & Co., of Pittsburg, Pennsylvania. The shipment was 10 tons, and was sold at Pittsburg for $30 per ton. From this time until 1881, when Mr. E. H. Woodward began operations in Arkansas, but little was done. From this date to 1887 the shipments amounted, it is estimated, to 5,000 tons or more. In October, 1885, the Keystone Iron and Manganese Company, of Pennsylvania, acquired large tracts of land, and have since been the largest shippers of ore from Arkansas, the total production up to December 31, 1891, being 18,111 tons. Other companies have since begun operations, but at present the output is quite small.

Batesville, from which the district takes its name, is a town of some 2,000 inhabitants, situated on the White river, and is the county seat of Independence county. A branch railroad runs from Newport, on the main line of the Iron mountain division of the Missouri Pacific, to Batesville. By this road and its branches the distance from Batesville to Saint Louis is 291 miles; to Cairo, 191 miles. The distance from Saint Louis to Pittsburg is 621 miles; to Chicago, 282 miles.

The manganese belt at Batesville is somewhat elliptical in shape, and has a length from east to west of about 16 miles, with an average breadth of about 3 miles. In this distance, however, the ore is by no means continuous, there being frequent interruptions and many places from which the ore is absent. It is probable that 7 or 8 square miles would cover the ascertained extent of the deposits. In its topography the ore district is an irregularly located group of rounded hills 100 to 500 feet above the general drainage level of the country. Two creeks run through the belt, Polk bayou on the east and Lafferty creek on the west. The ore belt is by no means well watered, however, and there is considerable difficulty in securing sufficient water for washing.

Geologically the country exhibits a monoclinic structure, dipping gently to the southeast from Lafferty creek toward Batesville. The main portion of the hills above water level are subcarboniferous limestone, covered with wash and crowned with broken chert or flint. Underneath the limestone is sandstone.

The ores occur in two horizons and under two distinct conditions:

1. The drift ores of the northwestern portion of the region.
2. The regular stratified bed of the eastern portion of the belt.

The drift manganese ore is found under the tops of the hills, in pieces from the size of a pea up to bowlders 2 and 3 and even 4 tons in weight. The diluvian deposit carrying the ore is from 5 to 25 feet in thickness, averaging, say, 9 feet, and rests upon a floor of limestone, a brown clay of varying thickness being interposed. This ore drift yields from 12 to 30 per cent of ore. Above the manganese drift is an earthy wash, interspersed with fragments of chert from 3 to 30 feet thick. At the Southern mine, from which over 5,000 tons have been taken, the stripping is 2 to 25 feet thick, and the drift in which the manganese is found 20 feet thick. The pit at this mine covers a little more than half an acre. At other pits opened the stripping is 10 feet and the ore drift 5 to 11 feet.

The source of the manganese ore lumps is believed to be the "cavernous limestone" found to the northwest of the ore belt, which originally occupied greatly elevated positions. Some of the formation near the mouth of Lafferty creek which has escaped the denuding agencies still carries veins of manganese ore 8 to 14 feet thick.

The ore, which is the black oxide, varies in quality from 40 to 60 units of metallic manganese, is of a bright luster, submetallic in color, subcrystalline, brittle, and with a fracture like that of cast iron. The following is the average of thorough analyses of 7 shipments:

AVERAGE COMPOSITION OF 7 ANALYSES OF BATESVILLE, ARKANSAS, MANGANESE ORE.

| | PER CENT. |
|---|---|
| Metallic manganese | 50.43 |
| Metallic iron | 3.66 |
| Phosphorus | 0.16 |
| Water | 2.28 |

A recent analysis shows the following constituents:

ANALYSIS OF BATESVILLE, ARKANSAS, MANGANESE ORE.

| | PER CENT. |
|---|---|
| Manganese | 58.76 |
| Iron | 3.75 |
| Phosphorus | 0.14 |

Analyses from 3 separate pits show the following:

ANALYSES OF BATESVILLE, ARKANSAS, MANGANESE ORES.

| COMPONENT PARTS. | Pit 1. | Pit 2. | Pit 3. |
|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* |
| Metallic manganese | 56.92 | 54.33 | 56.88 |
| Phosphorus | 0.10 | 0.29 | 0.18 |
| Insoluble matter | 2.10 | 1.34 | 0.72 |

A drift ore gave the following:

ANALYSIS OF BATESVILLE, ARKANSAS, DRIFT MANGANESE ORE.

| | PER CENT. |
|---|---|
| Metallic manganese | 55.95 |
| Phosphorus | 0.17 |
| Insoluble matter | 1.27 |

The mining cost depends chiefly on the amount of stripping and the percentage of ore in what is termed the "manganese ore drift". From 2 to 5 tons of earth must be removed for every ton of ore obtained, and the drift yields from 12 to 30 per cent of ore. Probably $2.50 will fully cover the mining cost.

The second body of ore is found between the buff-colored sandstone of Batesville and the subcarboniferous limestone which forms the floor of the deposits above noted; that is, the first-named deposit rests upon the limestone, the second underlies it, or, perhaps better, is in the horizon of transition between the limestone and the sandstone underlying it. This is a most peculiar deposit. The ore occurs in buttons or concretions imbedded in a red matrix of lean siliceous iron ore, the matrix adhering so closely to the "buttons" as to preclude so far all attempts to separate it from the rich manganese in the "buttons". The matrix splits up into rusty slabs 2 to 4 or 5 inches thick. This ore has but little commercial value. An average analysis of this deposit is as follows:

AVERAGE ANALYSIS OF "BUTTON" MANGANESE ORE FROM BATESVILLE, ARKANSAS.

| | PER CENT. |
|---|---|
| Metallic manganese | 16.46 |
| Metallic iron | 8.70 |
| Phosphorus | 0.60 |
| Insoluble matter | 43.65 |

The manganese deposits of southwestern Arkansas, as has already been stated, extend from Pulaski county on the east to Polk county on the west. This area varies in width from 4 or 5 to 10 or 12 miles, and in length is about 125 miles. It is not to be inferred, however, that manganese is found everywhere throughout this belt. It exists in a series of pockets, separated more or less widely by barren rocks. The lack of transportation facilities, as well as the excessively "pockety" character of the ores, has made all attempts to develop the deposits on a commercial scale failures.

The ores are oxides of manganese in their different mineralogical forms. The general course of the veins is from east to west. Analyses of surface specimens made by Professor W. B. Potter and Regis Chauvenet & Bro., of Saint Louis, give the following results:

ANALYSES OF POLK COUNTY, ARKANSAS, MANGANESE ORE.

| COMPONENT PARTS. | No. 1. | No. 2. | No. 3. | No. 4. |
|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Silica | 9.02 | 3.72 | 1.88 | 3.28 |
| Iron | | 0.50 | 35.39 | 4.40 |
| Metallic manganese | 58.36 | 55.80 | 27.68 | 52.22 |
| Phosphorus | 0.41 | 0.03 | 0.23 | 0.04 |

A more detailed analysis of No. 4 is as follows:

| | PER CENT. |
|---|---|
| Moisture | 0.441 |
| Silica | 3.287 |
| Alumina | 2.370 |
| Calcium oxide | 1.864 |
| Magnesium | 0.512 |
| Phosphorus | 0.044 |
| Iron | 4.403 |
| Manganese | 52.225 |
| Binoxide of manganese in ore | 69.832 |

An analysis of a soft ore taken from a shaft in the central part of this county gives 60.28 per cent metallic manganese and 0.17 per cent phosphorus. The specimens run from 60 to 70 per cent in binoxide and from 15 to 23 in the sesquioxide of manganese. Assays of 26 specimens sent to Birmingham and Sheffield, England, gave the first of the analyses on the following page.

ANALYSES OF MANGANESE ORE FROM POLK COUNTY, ARKANSAS.

| COMPONENT PARTS. | No. 1. | No. 2. | No. 3. | No. 4. |
|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Silica | 3.00 | 2.766 | 1.190 | |
| Iron | | | 2.696 | |
| Metallic iron | | | | 17.00 |
| Metallic manganese | 53.10 | 71.20 | 54.269 | 47.00 |
| Phosphorus | 0.13 | Trace. | 0.09 | 0.06 |

No. 2 is the average of 4 assays by Professor Waite, of the Missouri School of Mines. No. 3 is by Professor J. Blodgett Britton, of Philadelphia. No. 4 was made at the Smithsonian Institution.

Arkansas ranks the third state in the Union as a producer of manganese, it being exceeded by Virginia and Georgia. The statistics of the production for 1889 are given in the following table:

STATISTICS OF THE PRODUCTION OF MANGANESE IN ARKANSAS IN 1889.

| | |
|---|---|
| Total production (tons) | 2,528 |
| Total value | $23,173 |
| Value per ton | $9.17 |
| Number of employés | 96 |
| Total wages paid | $33,191 |
| Total capital invested in land, etc., and employed in business | $1,215,000 |
| Capital invested in land | $1,100,900 |
| Capital invested in buildings and fixtures | 38,500 |
| Capital invested in tools, implements, live stock, machinery, and supplies on hand | 35,600 |
| Capital invested in other items, including cash | 40,000 |

The work at most of the mines in this district was of such a desultory character that it is not possible to give any statement as to the average number of men employed and wages paid per day. The best average of wages that could be arrived at is as follows:

| | PER DAY. |
|---|---|
| Manager of mines | $3.33 |
| Foremen or overseers | 1.75 |
| Mechanics | 1.75 |
| Miners | 1.25 |
| Laborers | 1.10 |
| Boys under 16 years | 0.50 |

The production of manganese in Arkansas since the beginning of shipments in 1850, as far as the same can be ascertained, is given in the table following, together with the authority for the same. It has been estimated that the production of manganese in Arkansas prior to 1885 was 5,000 tons, but this may be questioned. The figures of production from 1881 to the close of 1884 are from the railroad reports of shipments. The figures from 1885 to 1888 are from the annual volume of Mineral Resources of the United States, while those of 1889 are the census figures. The figures from 1885 to 1889 have also been verified by the statements of shipments from the different points along the line of the Iron mountain division of the Missouri Pacific, which have been kindly furnished by the officers of that road.

PRODUCTION OF MANGANESE IN THE BATESVILLE DISTRICT OF ARKANSAS TO DECEMBER 31, 1889.

| YEARS. | Authority. | Tons. |
|---|---|---|
| 1850 to 1868 | Estimated | 400 |
| 1868 | ......do | 10 |
| 1881 | Railroad reports of shipments | 100 |
| 1882 | ......do | 175 |
| 1883 | ......do | 400 |
| 1884 | ......do | 800 |
| 1885 | Mineral Resources of the United States | 1,483 |
| 1886 | ......do | 3,316 |
| 1887 | ......do | 5,651 |
| 1888 | ......do | 4,312 |
| 1889 | Census | 2,528 |

### CALIFORNIA.

Manganese mining is an industry of but little importance in California. There is a small demand for the ore, chiefly for the manufacture of chlorine gas to be used in working sulphuret gold ores.

It is reported that the first manganese mining in California was done in 1867 by Mr. A. S. Ladd at Corral Hollow, Alameda county. Operations were carried on by Mr. Ladd until 1874. The ore mined, which is said to have amounted to 5,000 tons, was shipped to England and used in chemical manufacture. Since 1874, at which date Spanish manganese began to be imported into England, the market for the California manganese has been limited, and but little has been produced. The Ladd mine was purchased in 1874 by Mr. Justinian Caire, who produces a small amount each year, the production for 1889 being but 53 tons, running from 56 to 72 per cent of pyrolusite, and worth about $17 per ton. This was the only manganese produced in California in 1889. The ore at this mine, when fresh, is a hard, black, massive variety, occurring in a lenticular bed interstratified in red, yellow, and gray jasper.

An analysis of the manganese from the Corral Hollow mine is as follows:

ANALYSIS OF MANGANESE FROM CORRAL HOLLOW, CALIFORNIA.

| | PER CENT. |
|---|---|
| Manganese protoxide (MnO) | 75.26 |
| Oxygen (O) | 6.94 |
| Ferric oxide ($Fe_2O_3$) | 3.26 |
| Cobalt oxide (CoO) | Trace. |
| Lime (CaO) | 3.10 |
| Baryta (BaO) | None. |
| Magnesia (MgO) | 0.56 |
| Potash ($K_2O$) | 0.19 |
| Soda ($Na_2O$) | 0.58 |
| Water ($H_2O$) | 8.46 |
| Silica ($SiO_2$) | 1.98 |
| Total | 100.33 |

Other deposits of manganese are known to exist in California, but they are at present of no commercial importance.

The statistics of the production of manganese in California in 1889 are as follows:

STATISTICS OF THE PRODUCTION OF MANGANESE IN CALIFORNIA IN 1889.

| | |
|---|---|
| Total production (tons) | 53 |
| Total value | $901 |
| Value per ton at San Francisco | $17 |
| Number of employés | 10 |
| Total wages paid | $1,149 |
| Total capital invested in lands, etc., and employed in business | $2,400 |
| Capital invested in land | $2,000 |
| Capital invested in buildings and fixtures | 400 |

Regarding the total production of the state but little can be said. A prominent dealer on the coast reports, as published in the volume of Mineral Resources of the United States, 1886, that the total amount used in California was from 100 to 150 tons annually, the value at the mine being from $3 to $4 per ton for ore carrying from 50 to 60 per cent manganese. The price given for the ore mined in 1889, $17 per ton, was for ore delivered in San Francisco. If, as is stated above, 5,000 tons of ore were mined in this state up to 1874, it is possible that 6,000 tons of manganese may have been produced in California from the beginning of mining.

### COLORADO.

Colorado produces two classes of manganese-bearing ores, a manganiferous iron ore, used to some extent in the production of spiegeleisen, and a manganiferous silver ore, used as a flux in the smelting of silver-lead ores. The manganiferous iron ores carry as a rule but little silver, though in some cases the content of silver has been so high as to justify the working for silver of the slags produced at the blast furnaces at the time they were running on spiegeleisen.

These ores are all from the upper workings of the Leadville silver deposits, and carry manganese in varying quantities, from 5 up to 25 per cent, and occasionally 30 to 35 per cent, with 0 to 20 ounces of silver, 0 to 4 per cent of lead, 7 to 18 per cent in silica, and 30 to 50 per cent of iron.

As stated above, those high in manganese and low in silver are sold to steel works for the manufacture of spiegeleisen, while those carrying silver and not too high in silica are sold to the silver smelters and paid for according to the content of silver. It is usual for the smelters to buy these ores according to their so-called "silica excess", that is, the excess of iron and manganese over silica. This "silica excess" was placed in 1889 at 40 per cent; that is, there must be an excess of 40 per cent of manganese and iron over the silica in the ore, and it is then accepted and paid for, not according to its iron and manganese contents, but its silver. When the "excess" is above 40 per cent the excess is paid for at 10 cents a unit. Thus an ore with the following composition, viz, metallic manganese 25 per cent, metallic iron 30 per cent, silica 2.5 per cent, and silver 5 ounces, would have an excess of iron over silica of 52.5 per cent, or 12.5 per cent above the 40 per cent minimum excess. This, at 10 cents a unit, would be $1.25; the 5 ounces of silver, at 45 cents an ounce, would be $2.25, and the ore would be worth $3.50. It will not pay to produce these ores at less than $3.50, free on board at mines.

It has been estimated that from 300 to 500 tons of this ore are produced per day. On the basis of the lowest figures, that is, 300 tons a day for 300 days in the year, the production of manganiferous-silver-iron ore in the Leadville district would be 90,000 tons.

The actual shipments to spiegel furnaces in 1889 were 2,075 long tons. It is estimated that in addition to this 9,987 tons, containing over 20 per cent of manganese, were sold as flux ores, and returns of the sales of some 55,000 tons of flux ores carrying less than 20 per cent of manganese have been received. This would make the production in 1889 as follows:

PRODUCTION OF MANGANIFEROUS ORES IN COLORADO IN 1889.

| | TONS. |
|---|---|
| Manganiferous iron ores used for spiegeleisen | 2,075 |
| Manganiferous silver ores with 20 per cent and over of manganese | 9,987 |
| Manganiferous silver ores with less than 20 per cent of manganese | 55,000 |
| Total | 67,062 |

As these ores were not produced as manganese ores, no returns of capital, employés, etc., can be given. Analyses of these ores carrying 20 per cent and over of manganese are as follows:

ANALYSES OF MANGANIFEROUS IRON ORES IN COLORADO.

| COMPONENT PARTS. | Catalpa. | Crescent No. 1. | Crescent No. 2. | Hull. |
|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Iron | 34.90 | 17.80 | 21.15 | 35.00 |
| Silica | 6.90 | 6.30 | 7.00 | 3.83 |
| Manganese | 21.30 | 34.00 | 31.00 | 19.30 |
| Alumina | 4.15 | | | 2.00 |
| Lime | 0.34 | | | 0.46 |
| Magnesia | 0.07 | | | 0.45 |
| Sulphur | 0.06 | 0.027 | | |
| Phosphorus | 0.04 | 0.056 | | |
| Copper | Trace. | | | 0.03 |
| Oxide of lead | | | | 1.85 |
| Volatile matter | | | | 9.36 |
| Water | | | | 2.96 |

## CONNECTICUT.

Manganese ore in small quantities is frequently found in connection with the iron ores of the Salisbury district, though no manganese is ever produced separately. Attempts have been made to find the manganese ore in this district in sufficient quantities to pay for separating it from the iron ore, and though small quantities have been found from time to time, it never has been sufficient to pay for separation.

## GEORGIA.

One of the oldest and most continuously worked as well as one of the most important of the manganese ore-producing districts in the country is what is known as the Cartersville district, in Georgia. It is located in the northwestern part of the state, in Bartow county, the deposits extending into Cherokee county. Manganese was first mined here, so far as there are any records, in 1866 by the Pyrolusite Mining Company, 550 tons of ore having been mined and sold in that year.

In addition to the deposits in the neighborhood of Cartersville, some deposits have also been found elsewhere in the state, notably in what is known as the Cave Springs district and the Tunnel Hill mine, in the extreme northwestern portion of the state.

All of the deposits of manganese in this state resemble each other in the association of manganese with brown hematite and the general character of the ores. The pockets in which the ores of the Cartersville district are found are in closer proximity than those of any other part of the state, and the amount seems to be greater. Indeed, it is only the Cartersville district that is a producer of manganese on a commercial scale.

In its topography the Cartersville district is broken or knobby. The elevations, however, rarely exceed 200 feet above the drainage level of the country. The district is quite well watered by the Etowah river and its tributaries;

the manganese deposits, however, are so situated as to make it difficult to secure water for washing. The belt in which the manganese is found is some 12 miles long by 3 miles wide, though the explorations do not as yet justify any definite conclusions as to the extent of the deposits.

The ore occurs in pockets, the matrix appearing to be a residual clay, the result of the decay of the rock in place. The occasional regularity of the deposits is perhaps due to the concentration of the ore along certain strata, all traces of stratification being subsequently obliterated by the decay of the rock. The ore is frequently accompanied by fragments of sandstone, and is nowhere observed in proximity to any other rock.

The ore occurs in massive, crystallized, and needle forms, and is found in grains from the size of a mustard seed to that of a pea and even a walnut, and also in much larger masses. The ore varies greatly, not only in percentage of ore to gangue found in the pockets in which it occurs, but also in its richness. In the same mines some ore will run as high as 60 per cent metallic manganese, in exceptional cases even higher, while on the other hand pieces as low as 38 per cent are found.

The method of mining varies with the locality, and there can not be said to be any definite system. Sometimes the pockets of ore are worked by open cuts, sometimes by tunneling from the cuts or from the shaft. The method of washing the ore now in general use is to rotate it in a horizontal cylinder, into which water is admitted. These cylinders are made either with boiler-iron jackets and lined with cast iron, or else of iron slats running longitudinally with sixteenth-inch interstices between them. This method saves all but the very smallest particles of the ore.

The oldest mine now operated in this district, and the one which has produced the most ore, is what is known as the Dobbins mine. Mining began here in 1867, possibly in 1866, and has been carried on at intervals ever since. The ore is quite good, as will be seen from the following analyses:

PARTIAL ANALYSES OF MANGANESE ORE FROM DOBBINS MINE, CARTERSVILLE, GEORGIA.

| COMPONENT PARTS. | No. 1. | No. 2. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Metallic manganese | 52.726 | 48.832 |
| Metallic iron | 4.490 | 5.400 |
| Silica | 4.300 | 5.050 |
| Phosphorus | 0.188 | ............ |

The largest producer of manganese in this district in recent years has been the Dade mine. This deposit shows all the usual characteristics of the Cartersville district as described above. The ore varies greatly in its composition, and the pockets in which the ore has been found as greatly in the production. Some years the mine has produced but 100 tons; in others the production has reached nearly 4,000 tons. A series of analyses of ore from this mine is given in the following table:

ANALYSES OF MANGANESE ORE FROM THE DADE MINE, BARTOW COUNTY, GEORGIA.(a)

| COMPONENT PARTS. | No. 1. | No. 2. | No. 3. | No. 4. | No. 5. | No. 6. | No. 7. | No. 8. | No. 9. | No. 10. | No. 11. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Silica | 6.370 | 7.560 | 17.490 | 7.520 | 11.370 | 9.450 | 12.300 | 17.370 | 20.151 | 14.100 | 16.450 |
| Iron | 23.900 | 15.836 | 3.286 | 11.055 | 10.956 | 25.250 | 8.534 | 4.216 | 6.292 | 10.341 | 4.267 |
| Manganese | 30.320 | 36.489 | 40.354 | 41.430 | 36.950 | 27.711 | 42.933 | 42.612 | 41.655 | 39.226 | 43.457 |
| Phosphorus | 0.100 | 0.089 | 0.119 | 0.215 | 0.167 | 0.123 | 0.109 | 0.106 | 0.134 | 0.179 | 0.103 |

a All samples dried at 212°. Some ores run as low as 5 per cent manganese and 46 per cent iron.

Analyses from other mines in this district are given below:

ANALYSES OF MANGANESE ORE FROM ETOWAH, GEORGIA.

| COMPONENT PARTS. | From lot No. 303. | From lot No. 391. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Manganese dioxide | 87.960 | 87.600 |
| Oxides of iron and alumina | 2.520 | 9.135 |
| Sulphur | 0.008 | 0.010 |
| Phosphorus | 0.120 | 0.065 |
| Silica | 8.350 | 2.175 |
| Water and organic matter | 1.042 | 1.015 |
| Total | 100.000 | 100.000 |
| Metallic manganese | 54.975 | 54.750 |

### ANALYSIS OF MANGANESE ORE (RUN OF MINE) FROM THE MINES OF LARKIN SATTERFIELD, CARTERSVILLE, GEORGIA.

| | PER CENT. |
|---|---|
| Metallic manganese | 44.72 |
| Metallic iron | 5.19 |
| Silica | 17.03 |
| Phosphorus | 0.15 |
| Water | 9.20 |

As has already been stated, the first ferro-manganese produced in the United States as a commercial product was made at the Diamond furnaces, on Stamp creek, near Cartersville, in 1875 by Mr. Willard P. Ward. It is also claimed that this was the first economic success in the manufacture of ferro-manganese in the blast furnace, methods of its production at blast furnaces in Europe prior to this date being extremely wasteful of the manganese in the ore. Mr. Ward produced ferro-manganese containing as high as 67 per cent of manganese.

The statistics of the production of manganese in Georgia in the census year are as follows:

### STATISTICS OF THE PRODUCTION OF MANGANESE IN GEORGIA IN 1889.

| | |
|---|---|
| Total production (tons) | 5,208 |
| Total value | $50,143 |
| Value per ton | $9.63 |
| Number of employés | 117 |
| Total wages paid | $19,486 |
| Total capital invested in lands, etc., and employed in business | $247,350 |
| Capital invested in lands | $163,250 |
| Capital invested in buildings and fixtures | 32,800 |
| Capital invested in tools, implements, live stock, machinery, and supplies on hand | 21,900 |
| Capital invested in other items, including cash | 29,400 |

From reports received it would appear that wages are very small at manganese mines in this state. The average wages paid per day are as follows:

### AVERAGE WAGES IN MANGANESE MINING IN GEORGIA.

| | PER DAY. |
|---|---|
| Foremen or overseers | $1.75 to $2.50 |
| Mechanics | 1.25 to 1.50 |
| Miners | 1.10 to 1.60 |
| Laborers | 0.90 to 1.10 |
| Boys under 16 years | 0.50 |

The amount of manganese produced in Georgia has varied greatly, it having reached in 1887 9,024 tons, falling in 1888 to 5,568 tons and in 1889 to 5,208 tons. The following table gives, so far as the same has been ascertained, the production of manganese ore in Georgia since 1866. Most of this ore was produced in the Cartersville district.

### PRODUCTION OF MANGANESE ORE IN GEORGIA FROM 1866 TO 1889, INCLUSIVE.

| | TONS. | | TONS. |
|---|---|---|---|
| 1866 | 550 | 1878 | 2,400 |
| 1867 | 5,000 | 1879 | 2,400 |
| 1868 | | 1880 | 1,800 |
| 1869 | | 1881 | 1,200 |
| 1870 | | 1882 | 1,000 |
| 1871 | | 1883 | ..... |
| 1872 | | 1884 | ..... |
| 1873 | | 1885 | 2,580 |
| 1874 | 2,400 | 1886 | 5,981 |
| 1875 | 2,400 | 1887 | 9,024 |
| 1876 | 2,400 | 1888 | 5,568 |
| 1877 | 2,400 | 1889 | 5,208 |

### LAKE SUPERIOR REGION.

Several years since a deposit of what promised to be a true manganese ore was found near Copper Harbor, and considerable money was spent in developing it. The quantity, amounting to several hundred tons of what was supposed to be manganese ore, was shipped to western Pennsylvania. Only about 100 tons, however, proved to be high enough in manganese to be classed as manganese ore. This was used in the furnaces of the Cambria Iron Company at Johnstown, Pennsylvania.

Analyses of Lake Superior ore that was used for its manganese are as follows:

ANALYSES OF MANGANESE ORES FROM NEAR COPPER HARBOR, MICHIGAN.

| COMPONENT PARTS. | No. 1. | No. 2. | No. 3. | No. 4. |
|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Metallic manganese | 49.14 | 46.33 | 46.26 | 37.17 |
| Metallic iron | 1.22 | 5.68 | 1.00 | 2.30 |
| Phosphorus | 0.02 | 0.02 | 0.01 | 0.03 |
| Silica | 12.90 | 12.79 | ......... | 17.56 |
| Copper | 2.21 | 1.60 | 0.98 | 1.05 |

At the McComber mine, at Negaunee, pockets of manganiferous iron ores are occasionally met with, some of which are 25 feet across and of a good quality. An analysis by Mr. Charles E. Wright of an average sample of this ore is as follows:

ANALYSIS OF McCOMBER, MICHIGAN, MANGANESE ORES.

| | PER CENT. |
|---|---|
| Oxide of iron | 71.430 |
| Oxide of manganese | 17.250 |
| Alumina | 2.200 |
| Phosphoric acid | 0.073 |
| Sulphuric acid | 0.073 |
| Silica | 2.050 |
| Water combined | 5.320 |
| Undetermined | 1.604 |
| | 100.000 |
| Metallic iron | 49.800 |
| Metallic manganese | 10.900 |
| Phosphorus | 0.034 |
| Sulphur | 0.021 |

In 1877 advantage was taken of the fact that the Munising furnace was about blowing out for repairs to make a test of this ore for the manufacture of spiegeleisen, some 50 tons being charged. An analysis of the pig gave 10.60 per cent of manganese and 0.12 per cent of phosphorus.

While there are, strictly speaking, no manganese mines in the Gogebic region of Lake Superior, the ores from many of the mines in this district carry a small percentage of manganese. At times thin streaks of high-grade manganese ore are found in the iron-ore bodies. This has been notably the case in the mines that were formerly called the Bessemer and Bonnie, some samples of high-grade crystallized pyrolusite having been found.

While it is true that no mines in the Gogebic region are worked as manganese mines, at least 2 of the iron mines (the Colby and the Jackson) in this district graded the ore produced in 1889 into two or possibly three grades: first, iron ore proper; second, manganiferous iron ore containing 4 per cent and less of manganese; and, third, manganiferous iron ore containing 10 or 11 per cent of manganese.

The Colby mine, which has been the largest producer of this manganiferous iron ore, is in Ontonagon county, Michigan, near the Montreal river, which is the dividing line between Wisconsin and Michigan. The ore, which is a pronounced red hematite, as is most of the ore of this district, occurs in large lenses or pockets, some of which have a length of 1,000 feet and a width in places of 150 feet. At the Colby mine there are 2 ore zones, parallel to each other and about 150 feet apart. All of the iron ore in both of these zones carries a greater or less percentage of manganese, the average of the northern vein or zone being some 2 per cent of manganese, with 61 per cent of iron and 0.049 per cent of phosphorus; the southern vein or zone carries 4 per cent of manganese, with 59.30 per cent of iron and the same amount of phosphorus as the northern vein. In some cases, however, the manganese is as high as 33 per cent. During the year 1889 the Colby mine shipped 25,560 tons of ore which contained, per cargo samples, 54.60 per cent of iron and 8.92 per cent of manganese, and 50,018 tons of ore that contained 56.42 per cent of iron and 6.74 per cent of manganese.

Analyses of the ore from the Colby mine are as follows:

ANALYSES OF "BEAVER" MANGANIFEROUS IRON ORE FROM THE COLBY MINE, LAKE SUPERIOR.

| COMPONENT PARTS. | No. 1. | No. 2. | No. 3. |
|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* |
| Iron | 54.808 | 57.784 | 54.540 |
| Manganese | 8.127 | 6.850 | 9.112 |
| Silica | 3.550 | 3,550 | 3.720 |
| Phosphorus | 0.064 | 0.071 | 0.062 |
| Moisture | 8.000 | 12.000 | 9.000 |

All of the preceding analyses were furnished by Mr. H. M. Curry, of Carnegie Brothers & Co., limited.

On the east side of one of the workings of the Jackson Iron Company a deposit of manganiferous iron ore is found. The deposit is very "pockety". Sometimes mining may be conducted for months without finding any manganese ore, and then a pocket will be struck which will yield a considerable quantity. In some years the mine has produced from 5,000 to 10,000 long tons, and in others it has run as high as 20,000 tons. In 1889, 5,341 tons were mined. The average percentage of manganese contained in the shipments of the Jackson Iron Company in 1889 was 8.05. The average analysis of the ore shipped was as follows:

| | PER CENT. |
|---|---|
| Iron | 52.950 |
| Manganese | 8.050 |
| Silica | 8.270 |
| Phosphorus | 0.054 |

In what is known as the Saint Croix district some very interesting developments in connection with manganiferous iron ore have been made in the past, and there are promising indications for the future.

Saint Croix county, Wisconsin, in which these developments have been made, is in the extreme western part of the state, where the boundary thrusts itself out into Minnesota. Manganese seems to exist in three forms; that is, as wad, which is found in pockets from 1 to 5 feet in depth, the ore carrying from 15 to 35 per cent of manganese; as a manganiferous iron ore (limonite), carrying from 0.5 to 15 per cent of manganese, and as a real manganese ore. Analyses of the ore from Saint Croix are as follows:

ANALYSES OF MANGANESE ORES FROM SAINT CROIX, WISCONSIN.

| COMPONENT PARTS. | No. 1. | No. 2. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Silica | 11.350 | 5.200 |
| Iron | 2.259 | 1.000 |
| Manganese | 47.031 | 48.879 |
| Combined water | 6.314 | 6.717 |
| Phosphorus | 0.017<br>0.016 | 0.022 |

In view of the fact that all of the mines in Michigan that produce manganese or manganiferous iron ores are operated as iron mines, it is impossible to give any statement as to the number of employés, amount of wages paid, or capital invested in the production of manganese, as these items are all included in the report on the iron-ore production of the mines supplying it, and it is impossible to state what percentage of these items should be charged to manganese and what to iron ore. The only statistics, therefore, that can be given are production and value, and they are as follows:

STATISTICS OF THE PRODUCTION OF MANGANIFEROUS IRON ORE IN LAKE SUPERIOR REGION IN 1889.

| | |
|---|---|
| Production averaging about 9 per cent manganese (tons) | 31,341 |
| Production averaging about 6.74 per cent manganese (tons) | 50,018 |
| Total production (tons) | 81,359 |
| Total value of ore at mines | $264,417.00 |
| Average value per ton | 3.25 |

The production of manganiferous iron ore in Lake Superior region since 1886, so far as the same has been ascertained, is as follows:

| | TONS. |
|---|---|
| Production in 1886: | |
| Production averaging 2 per cent of manganese | 100,000 |
| Production averaging 4 per cent of manganese | 157,000 |
| Total | 257,000 |
| Production in 1887: | |
| Production averaging 4 per cent of manganese | 200,000 |
| Production averaging 10 per cent of manganese | 10,000 |
| Total | 210,000 |
| Production in 1888: | |
| Production averaging 4 per cent of manganese | 189,574 |
| Production averaging 11 per cent of manganese | 11,562 |
| Total | 201,136 |
| Production in 1889: | |
| Production averaging 6.74 per cent of manganese | 50,018 |
| Production averaging 9 per cent and over of manganese | 31,341 |
| Total | 81,359 |

### MAINE.

In Maine no manganese was produced in 1889. Considerable bog ore was mined at one time in Knox, Oxford, and Hancock counties. In Blue Hill, Hancock county, what is termed a silicate of manganese has been mined at several dates since 1863. The manganese occurs in a vein about 15 feet in width on the summit of Blue Hill. The hill is a mass of contorted gneiss rock, the manganese running through it east-northeast by west-southwest. In 1877 and 1878 some 120 tons were taken out of this mine for use as flux at the furnace of the Katahdin iron works. Some 60 tons were taken out in 1886 for use as flux at the same furnace.

The following are analyses of manganese ore from Blue Hill, Maine:

ANALYSES OF MANGANESE ORE FROM BLUE HILL, MAINE.

| COMPONENT PARTS. | No. 1. | No. 2. | No. 3. |
|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* |
| Protoxide of iron | 14.01 | 24.91 | 12 |
| Protoxide of manganese | 35.13 | 29.72 | 15 |
| Alumina | 7.45 | 3.04 | |
| Lime | 3.49 | 5.02 | |
| Silica | 35.84 | 35.70 | 39 |
| Phosphoric acid | 1.02 | | |

### MARYLAND.

Manganese ore was at one time mined to some extent in Maryland from a deposit near Brookeville, in Montgomery county, and also from a deposit on the north side of the Potomac river, opposite Harpers Ferry. No manganese has been produced in this state for a number of years.

### MASSACHUSETTS.

Pyrolusite is frequently found in connection with the limonite ores in the western part of Massachusetts, as it is so frequently found in connection with the same ores all through the Appalachian region. It is rarely, if ever, found in sufficient quantities to justify its separation for sale as manganese ore.

### MISSOURI.

Considerable quantities both of manganese ores and manganiferous iron ores have been mined in Missouri for use in the Saint Louis furnaces in the manufacture of spiegeleisen. These ores have been derived chiefly if not entirely from what Professor Pumpelly has termed the "porphyritic" region of Pilot Knob and vicinity, and are usually found associated more or less intimately with iron ore. In 1881 some 2,000 tons of this ore were taken from 1 mine in this section, but since that year none has been mined on a commercial scale.

On what has been termed the "Cuthbertson-Buford Hill" in this Pilot Knob region several deposits occur, from which the ore already referred to was chiefly derived. On the Cuthbertson tract masses of float manganese ore, varying greatly in size, are found, and in the hill occurs a bedded deposit of irregular tubular masses of manganese ore bedded in red ocherous clay. The manganese exists in the ore as red sesquioxide, with a probable admixture of binoxide. This ore is a true manganese ore, as will be seen from the following analysis:

ANALYSIS OF MANGANESE ORE FROM CUTHBERTSON, MISSOURI. (*a*)

| | PER CENT. |
|---|---|
| Manganese as protoxide | 68.20 |
| Peroxide of iron | 3.30 |
| Insoluble siliceous matter | 0.44 |
| Metallic manganese | 52.47 |

*a* Chauvenet and Blair, chemists.

The ore of the Buford bank, adjoining the Cuthbertson tract, is a manganiferous iron ore, but it occurs in a bedded deposit similar to Cuthbertson's manganese ore. An analysis of this by Mr. Chauvenet gave the following results:

ANALYSIS OF MANGANESE ORE FROM BUFORD BANK, MISSOURI.

| | PER CENT. |
|---|---|
| Manganese as protoxide | 15.84 |
| Peroxide of iron | 68.30 |
| Insoluble matter | 8.54 |
| Sulphur | 0.02 |
| Phosphoric acid | 0.10 |
| Or— | |
| Metallic manganese | 12.32 |
| Metallic iron | 47.81 |
| Phosphorus | 0.04 |

A small amount of manganiferous iron ore was taken from Buford mountain some years since for use at the Vulcan steel works at Saint Louis. The ore averaged about 15 per cent manganese. The deposit was some distance from the railroad, and it was not deemed advisable to prosecute mining.

Near Cuthbertson, on Mr. Marble's land, Professor Pumpelly found a manganese deposit, forming an inner stratified layer 3 to 5 inches thick in a decomposed porphyry, showing 51.06 per cent of manganese as protoxide.

Mr. P. N. Moore, an assistant of the geological survey of Missouri, reports the existence in Reynolds county, as one of the members of a series of bedded porphyry rocks, an ore of the black oxide of manganese, occurring in narrow, comby strings in the porphyry. A very compact, hard specimen of this, so hard that it struck fire with steel, gave Mr. Chauvenet the following analysis:

ANALYSIS OF MANGANESE ORE FROM REYNOLDS COUNTY, MISSOURI.

| | PER CENT. |
|---|---|
| Manganese as protoxide | 37.04 |
| Manganese as peroxide | 5.48 |
| Insoluble silica | 45.55 |

The 2,000 tons referred to above as being mined in this state in 1881 were from the property of the Arcadia Mining Company, near Arcadia, Missouri. The analysis was as follows:

ANALYSIS OF MANGANESE FROM ARCADIA, MISSOURI. (*a*)

| COMPONENT PARTS. | No. 1. | No. 2. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Metallic maganese | 64.98 | 58.02 |
| Metallic iron | 2.82 | 3.35 |
| Phosphorus | 0.04 | 0.03 |
| Silica | 2.82 | 3.35 |

*a* Farrell, chemist.

This ore was used in the furnaces of the Missouri Furnace Company at Saint Louis in such quantities as to give 0.75 per cent of manganese in the iron. The analyses above given were of exceptionally rich specimens of the ore.

## NEVADA.

A small amount of manganese has been produced in Nevada, near Golconda, on the Central Pacific railroad, in the valley of the Humboldt river, but the expense of getting it to market has been so great that no use has been made of it. A few tons, 13.25, are said to have been shipped a few years ago to San Francisco, but the cost of freight to market was too great to make the venture a commercial success. The deposit is not worked at present.

The ore is a massive, black, glossy oxide of manganese with the following component parts:

ANALYSIS OF MANGANESE ORE FROM GOLCONDA, NEVADA.

| | PER CENT. |
|---|---|
| Manganese protoxide | 65.66 |
| Oxygen | 10.31 |
| Ferric oxide | 3.32 |
| Alumina | 0.34 |
| Cobalt oxide | (*a*) |
| Lime | 3.44 |
| Baryta | 5.65 |
| Magnesia | 1.26 |
| Potash | 0.35 |
| Soda | None. |
| Water and organic matter | 4.16 |
| Phosphoric acid | None. |
| Tungsten acid | 2.78 |
| Silica | 1.70 |
| Total | 98.97 |
| Manganese | 50.85 |
| Iron | 2.32 |
| Tungsten | 2.20 |
| Phosphorus | None. |
| Moisture | 4.97 |

*a* Not determined.

## NEW HAMPSHIRE.

Some manganese has been found associated with the iron ores that were worked in this state many years ago, but manganese as a separate ore has never been produced. Some pyrolusite is said to have been found in connection with silicate of manganese in Cheshire county.

## NEW JERSEY.

The first spiegeleisen produced in the United States as a commercial product was from the zinc ores of Sussex county, New Jersey. These ores, which may be termed manganiferous zinc ores, are mined primarily for their zinc contents, though they carry a considerable percentage of manganese. The selected Buckwheat ore carries from 26.34 to 28.78 per cent of zinc, and from 12.27 to 13.65 per cent of metallic manganese; the lean Buckwheat, from 21.14 to 21.79 per cent of zinc and from 12.12 to 12.35 per cent of manganese; the Sterling ore, from 18.76 to 23.61 per cent of zinc and 9.46 to 11.13 per cent of manganese; while the Front vein carries 18.41 per cent of zinc and 13.79 per cent of manganese. The analyses of these ores are given in connection with the discussion on the production of spiegeleisen and ferro-manganese on page 329 of this report.

The residuum from working these manganiferous zinc ores for their zinc contains more manganese per ton of residuum than the ore itself, and it is this residuum that is smelted in the blast furnace for spiegeleisen. Analyses of this residuum or clinker, as given in a subsequent part of this report, show from 12.13 to 16.29 per cent of manganese, though it is unusual to find as much as 14.5 per cent in the residuum. The average content is from 9 to 14 per cent.

As the character of these ores and the residuum and its uses are so thoroughly discussed under the head of "Manufacture of spiegeleisen and ferro-manganese", nothing more need be said regarding them at this place.

The total residuum from these ores used in the manufacture of spiegeleisen in 1889 was 43,648 tons, producing 14,124 tons of spiegel.

## NORTH CAROLINA.

Reported discoveries of manganese ore in North Carolina are quite frequent. Up to the present time it has not been found in paying quantities. The amounts reported as being mined in this state have been only trial lots. Some of the deposits of North Carolina appear to hold the same relation to the iron ores and to the several mountain ranges as do many of the deposits of Virginia. At Buckhorn iron mine, located in Chatham county, on the borders of Harnett county, sheets of laminated black oxide of manganese from 1 to 2 inches thick occur, while in the lower part of the bed the iron ore is quite manganiferous. An analysis of this lower part is given as follows:

ANALYSIS OF MANGANESE ORE FROM CHATHAM COUNTY, NORTH CAROLINA.

| | PER CENT |
|---|---|
| Oxide of manganese | 22.80 |
| Metallic iron | 18.41 |
| Phosphorus | 0.02 |
| Silica | 30.50 |
| Alumina | 19.20 |

It will be seen from this analysis that the ore is a silicate of manganese.

Quite thorough explorations for manganese have been made in the Warm Springs basin. This basin is about 8 miles long and from 1 to 3 miles wide. On its northern end are large beds of limonite, while a continuous belt of manganese ore is found on its western side.

Analyses of this ore are as follows:

AVERAGE COMPOSITION OF MANGANESE ORE FROM THE WARM SPRINGS BASIN, NORTH CAROLINA.

| ANALYSES. | Metallic manganese. | Phosphorus. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| No. 1 | 41.710 | 0.103 |
| No. 2 | 38.270 | 0.064 |
| No. 3 | 42.800 | 0.187 |
| No. 4 | 48.010 | 0.157 |
| No. 5 | 44.090 | 0.254 |
| Average | 42.976 | 0.153 |

Other and more complete analyses of ore from the Warm Springs region, North Carolina, are as follows, No. 1 being by Carnegie Brothers & Co., limited, of Pittsburg, and No. 2 by Dr. Charles W. Dabney, jr.:

ANALYSES OF MANGANESE ORE FROM MADISON COUNTY, NORTH CAROLINA.

| COMPONENT PARTS. | No. 1. | No. 2. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Silica | 10.12 | |
| Iron | 2.65 | 12.40 |
| Manganese | 48.93 | 49.86 |
| Phosphorus | 0.17 | |
| Gangue | | 0.86 |
| Manganese dioxide | | 78.87 |
| Sesquioxide | | 17.72 |

There is a series of beds containing manganese associated with the King mountain schists (slates) of Gaston, Lincoln, and Catawba counties, which are superficially changed to black oxide. One notable locality is near the old forge on Crowder creek. The composition of this ore is as follows:

ANALYSIS OF MANGANESE ORE ASSOCIATED WITH THE KING MOUNTAIN SLATES, NORTH CAROLINA.

| | PER CENT. |
|---|---|
| Silica | 40.395 |
| Oxide of iron | 12.146 |
| Alumina | 9.025 |
| Phosphoric acid | 0.030 |
| Sulphuric acid | 0.024 |
| Sulphide of iron | 0.218 |
| Protosesquioxide of manganese | 29.780 |
| Lime and magnesia | (*a*) |
| Metallic iron | 8.602 |
| Metallic manganese | 21.450 |
| Phosphorus | 0.013 |
| Sulphur | 0.112 |

*a* Not determined.

The only mine worked in this state, so far as has been ascertained, is located in the northwestern corner of Madison county. 3 car loads of ore were shipped in 1888, 2 to Liverpool and 1 to Pittsburg. The ore consists of pyrolusite and a black oxide containing from 48 to 50 per cent of metallic iron. It exists both in lumps and in a soft pulverulent variety, very pure and much crystallized. In 1889 47 tons were mined in this state from the Warm Springs district. 2 car loads, containing 30 tons, were shipped to Pittsburg and 1 to Johnstown, Pennsylvania. The ore, however, contained too much phosphorus to permit of its use in the manufacture of ferro-manganese and spiegeleisen.

The statistics of the production of manganese in North Carolina in the census year are as follows:

STATISTICS OF THE PRODUCTION OF MANGANESE IN NORTH CAROLINA IN 1889.

| | |
|---|---|
| Total production (tons) | 47 |
| Total value | $470 |
| Value per ton | $10 |
| Total number of employés | 2 |
| Total wages paid | $160 |
| Total capital used in developing | $250 |

The production of manganese in North Carolina, so far as the same has been ascertained, from 1886 to 1889, inclusive, is as follows:

PRODUCTION OF MANGANESE IN NORTH CAROLINA FROM 1886 TO 1889, INCLUSIVE.

| | TONS. |
|---|---|
| 1886 | 15 |
| 1887 | 14 |
| 1888 | 50 |
| 1889 | 47 |

## PENNSYLVANIA.

Manganese ore is of quite frequent occurrence in Pennsylvania, although but few deposits have yet been discovered that have been worked. Perhaps the largest mines worked in the state were 2 at Ironton, in Lehigh county, in connection with iron ore. In the iron mines of the Ironton company manganese ore has been twice met with in local beds in considerable quantities. One deposit overlaid a portion of the brown hematite, and the other was just above the limestone under the brown hematite, and separated from it by a red clay. Several hundred tons were taken from these beds. The following analyses were made by Mr. A. S. McCreath (No. 1) and Mr. Henry Pemberton, jr. (No. 2):

ANALYSES OF MANGANESE ORES FROM LEHIGH COUNTY, PENNSYLVANIA.

| COMPONENT PARTS. | No. 1. | No. 2. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Metallic manganese | 52.63 | 56.58 |
| Metallic iron | 2.56 | .......... |
| Phosphorus | 0.06 | Trace. |
| Sulphur | Trace. | .......... |

Another sample from the Ironton company's mine gave:

ANALYSIS OF MANGANESE ORE FROM THE IRONTON COMPANY'S MINE.

| | PER CENT. |
|---|---|
| Metallic manganese | 17.648 |
| Metallic iron | 26.400 |
| Phosphorus | 0.095 |
| Sulphur | 0.010 |
| Insoluble residue | 21.860 |

In this district the brown hematites often contain some manganese, 0.5 per cent to 3 per cent not being uncommon.

In addition to its occurrence in these Lehigh mines, it has been noticed in many of the mines of Northampton and Berks counties, at places in Blair, Centre, and Huntingdon counties, and at various localities on Broad mountain. In the No. XI red shale of the Ground Hog valley, in Broad Top, there is a lead of manganese ore 2 to 3 feet thick, carrying 50 per cent metallic manganese and 0.4 per cent phosphorus.

At an iron-ore bank in York county, near Myers Mills, leased by the Ashland Iron Company, of Maryland, is a manganiferous iron ore (limonite) that gives the following analysis (McCreath):

ANALYSIS OF MANGANIFEROUS IRON ORE FROM YORK COUNTY, PENNSYLVANIA.

| | PER CENT. |
|---|---|
| Metallic manganese | 15.934 |
| Metallic iron | 32.400 |
| Phosphorus | 0.651 |
| Sulphur | 0.027 |

Near the close of 1889 a deposit that promises to be of some importance was discovered in Caernarvon township, Berks county, by Dr. D. Heber Plank. Dr. Plank states that manganiferous ores may be found all along the western or mesozoic border of the Morgantown or upper Conestoga valley in the little basins or valleys running down from the shale and conglomerate sandstone belt and where drainage is into the Conestoga creek, and that this outcrop of manganese has been observed for at least 5 or 6 miles, commencing at a point 1.5 miles northeast of Joanna station, Wilmington and Northern railroad, thence west-northwest through northern Caernarvon, southern Robeson, and southern Brecknock townships. The farmers of the district call it black sandstone. Dr. Koenig, of the University of Pennsylvania, who made an examination of this district, states that the present surface is chiefly composed of a conglomeratic sandstone impregnated with psilomelane or hard manganese ore, this latter occurring in dendrites in little nests and larger nodules, and having the following composition:

ANALYSIS OF MANGANESE ORE FROM BERKS COUNTY, PENNSYLVANIA.

| | PER CENT. |
|---|---|
| Manganimanganic oxide | 22.900 |
| Barium oxide | 3.020 |
| Potassium oxide | 1.250 |
| Phosphoric oxide | 0.206 |
| Silica | 58.280 |
| Iron oxide and alumina | 7.120 |
| Cobalt oxide | Trace. |
| Water | 7.620 |
| Total | 100.396 |
| Metallic manganese | 16.500 |
| Phosphorus | 0.144 |

No manganese was produced in Pennsylvania in 1889.

As stated above, few of these deposits are of sufficient extent to justify mining for manganese. Others are too high in phosphorus for steel purposes or too low in manganese to justify shipping abroad for chemical manufacture.

In this state there are 3 blast furnaces making ferro-manganese and spiegel iron regularly, that of the Lehigh Zinc and Iron Company, at Bethlehem, using zinc residuum; one of the furnaces of the Cambria Iron Company, and furnace "A" of the Edgar Thompson steel works at Pittsburg, both of the latter using manganese and manganiferous iron ores.

### RHODE ISLAND.

Bog manganese ore and oxides of manganese have been found in Rhode Island, but never in sufficient quantities to justify mining.

### SOUTH CAROLINA.

Very little manganese has been produced in this state, though no doubt deposits exist here as they do in North Carolina. Indeed, what is said in a general way as to North Carolina deposits will apply equally well to those of South Carolina, except that smaller quantities have been found in the latter state. The only deposit that appears to have been worked to any extent is that of the Manganese Mining Company, which operated in 1885 and 1886 on the Dorn lands, near McCormick. It is reported that some 300 tons had been mined up to the close of 1886. The following is an analysis of this ore:

ANALYSIS OF MANGANESE ORE FROM DORN COUNTY, SOUTH CAROLINA.

| | PER CENT. |
|---|---|
| Peroxide of manganese | 75.28 |
| Protoxide of manganese | 3.73 |
| Oxide of iron | 14.56 |
| Alumina | 2.63 |
| Phosphoric acid | 0.24 |
| Silica | 3.54 |
| Sulphur | 0.02 |
| Total | 100.00 |

The metallic manganese in the above ore is 50.34 per cent, and phosphorus 0.11 per cent. All of the manganese produced in South Carolina was from this neighborhood and from 2 workings. An analysis of this ore is as follows:

ANALYSIS OF MANGANESE ORE FROM McCORMICK, SOUTH CAROLINA.

| | PER CENT. |
|---|---|
| Manganese | 45.018 |
| Iron | 2.750 |
| Silica | 8.100 |
| Phosphorus | 0.085 |
| Moisture | 9.000 |

The statistics of the production of manganese in South Carolina in 1889 are as follows:

STATISTICS OF THE PRODUCTION OF MANGANESE IN SOUTH CAROLINA IN 1889.

| | |
|---|---|
| Total production (tons) | 124 |
| Total value | $744 |
| Value per ton | $6 |
| Total number of employés | 6 |
| Total wages paid | $400 |
| Total capital invested in lands, etc., and employed in business | $5,000 |
| Capital invested in lands | $2,500 |
| Capital invested in buildings and fixtures | 750 |
| Capital invested in tools, implements, live stock, machinery, and supplies on hand | 250 |
| Capital invested in other items, including cash | 1,500 |

The total production of manganese ore in South Carolina, so far as the same has been ascertained, is as follows:

TOTAL PRODUCTION OF MANGANESE ORE IN SOUTH CAROLINA.

| | TONS. |
|---|---|
| 1885 and 1886 | 300 |
| 1887 | 45 |
| 1888 | 50 |
| 1889 | 124 |

### TENNESSEE.

So far as has been learned, the first manganese produced in the United States was in 1837, near Whitfield, in Hickman county, Tennessee. It was for use in coloring earthenware, and it has been used for this purpose quite continuously ever since. The production, however, has been but a few hundred pounds each year.

Lumps of manganese oxides are frequently found in the iron-ore regions of Tennessee. They are isolated pieces, however, the ore rarely, if ever, occurring in beds or deposits worthy of any special notice. Hickman county is in the western iron region of the state, in which iron was extensively made before the war, and in which some furnaces are now at work. The ore in this region is limonite, and it is with this and with the cherty gravel scattered over the surface of the country that the isolated lumps of manganese ores are found.

Small masses of manganese oxide more or less pure are often met with on nearly all the low, cherty regions of the valley of east Tennessee. They also occur, as in Greene county, with iron ore at intervals, at the foot of the extreme eastern mountains (the Unakas) all the way from Virginia to Georgia. Manganese ores are also found all down the Chilhowee mountain range, but in pockets and too far from any railroad to justify their transportation.

The production of manganese in Tennessee in 1889 was but 30 tons. The statistics of this production are as follows:

STATISTICS OF THE PRODUCTION OF MANGANESE IN TENNESSEE IN 1889.

| | |
|---|---|
| Total production (tons) | 30 |
| Total value | $120 |
| Value per ton | $4 |
| Total number of employés | 3 |
| Total wages paid | $70 |
| Total capital | $100 |

The capital employed was simply that necessary in putting down experimental shafts.

The total production of manganese, so far as the same has been ascertained, is shown in the following table. This is exclusive of the small amount worked each year since 1837 in Hickman county for use in coloring earthenware.

TOTAL PRODUCTION OF MANGANESE ORE IN TENNESSEE.

| | TONS. |
|---|---|
| 1886 | 50 |
| 1887 | -- |
| 1888 | 16 |
| 1889 | 30 |

## VERMONT.

According to Hitchcock's Geology of Vermont, published in 1861, considerable manganese ore had been shipped from Brandon and Chittenden, in that state, to England. Dr. Prime, of Brandon, informs Dr. Penrose, of the geological survey of Arkansas, that deposits were worked in the neighborhood of Brandon about 75 years ago, but that the manganese which was found in connection with the iron ore was avoided, as it was thought to be injurious to the iron, and that no manganese was produced until about 1859.

The deposits of any importance that have been discovered in this state are at South Wallingford and Brandon, in the Otter Creek valley, and at Chittenden. The most important developments, however, have been at Brandon and South Wallingford. The South Wallingford mines are located at South Wallingford, Rutland county, at the foot of the Green Mountain range, half a mile east of the Bennington and Rutland railroad.

According to a statement furnished the writer by Mr. Bradley and published in the volume of Mineral Resources of the United States, 1888, these deposits were worked to some extent some 60 or 70 years ago for their iron ore. The quantity of manganese they carried, however, was such, in the condition of iron smelting at that time, that the persons mining were not able to utilize the ore, and it went to waste. Some 40 years ago Messrs. Lapham & Vail mined the ore and worked it in a forge near by, producing sleigh shoes, bars, butcher knives, etc. The mine was abandoned because the miners believed they had won all the ore. It is now known, however, that they had only worked on the top of the deposit. They tried to sink a shaft to reach ore which they supposed existed below, but they struck a large vein of water and abandoned the operation. Some 15 years since a few hundred tons of ore were mined, and again the mine was abandoned. Some 2 years since Messrs. Bradley & Lyons commenced operations. They found it necessary to go deeper into the mine, and drove in a tunnel at the foot of the mountain 517 feet into a siliceous limestone formation. After drifting through this for 300 feet they encountered ocher for 100 feet or more, after which they turned north, encountering a large body of excellent manganese ore. The ore is found between a wall of siliceous limestone on the west and broken massive quartz on the east, the walls being 150 feet apart. Beneath the drift were found ochers, clays, kaolin, and manganese ore, the latter lying near the quartz, with a seam of black ocher between the ore and wall. The deposit dips about 40° to the east; the trend of the vein is south. Next to the manganese ore on the west is a shell of brown ore. In the mine all grades of ore, from the ordinary brown hematite to the highest grade of manganese, are found. Much of the hematite ore is of a beautiful stalactitic formation. Cubical and needle crystals are also found. One of the strange features of this mine is this ore channel, as the proprietors term it, between the two walls before noted.

Analyses of this ore are as follows:

ANALYSES OF SHIPMENTS OF MANGANESE FROM SOUTH WALLINGFORD, VERMONT, FOR THE WINTER OF 1887-1888, SHIPPED AS MINED, UNWASHED.

| Silica. | Iron. | Manganese. | Phosphorus. |
|---|---|---|---|
| *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| *a*9. 520 | 33. 383 | 20. 141 | 0. 088 |
| *a*10. 000 | 26. 104 | 26. 182 | 0. 064 |
| *a*7. 480 | 32. 128 | 20. 602 | 0. 073 |
| *b*12. 500 | 14. 650 | 34. 393 | 11. 151 |

*a* This ore was taken from only 30 to 50 feet below surface.

*b* Analysis of shipments for winter 1888-1889, ores at 50 to 60 feet deeper than specified above. Samples for analysis were from car loads of unwashed ore from vein some 100 feet south.

ANALYSES OF WASHED ORE FROM VEIN 500 FEET NORTH OF ORE SPECIFIED IN ABOVE TABLE, AT 27 FEET FROM SURFACE, MADE JUNE, 1888.

| Silica. | Iron.(*a*) | Manganese.(*b*) | Phosphorus. |
|---|---|---|---|
| *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| 9. 230 | 7. 180 | 44. 107 | Not given. |
| 3. 100 | 25. 000 | 35. 000 | 0. 061 |
| 7. 900 | 4. 970 | 48. 778 | 0. 111 |

*a* Samples from face of drift, January 5, 1889, as near as could average; selection, ore 40 to 50 feet under that given in first table.

*b* From vein 100 feet south of above, average as near as possible, December 3, 1888.

The massive manganese ore in this deposit occurs in the form of geodes or "pot ore", which are sometimes filled with water and locally known by the miners as "water holes". Occasionally well-formed stalactites of massive black ore are found in the interiors of the cavities.

This deposit was worked by Carnegie Brothers & Co., limited, in 1889 and part of 1890, mining being discontinued by them before the end of the latter year.

The Brandon mine is in the town of Brandon, on the Central Vermont railroad, in Rutland county. Manganese ores were first worked here in 1860, and have been mined at intervals since. Explorations were made at this mine in 1889 and 1890 by Messrs. Carnegie Brothers & Co., limited, but were abandoned in 1890, and the old pits have caved in.

The statistics of the production of manganese in Vermont in 1889 are as follows:

STATISTICS OF THE PRODUCTION OF MANGANESE IN VERMONT IN 1889.

| | |
|---|---|
| Total production (tons) | 1, 576 |
| Total value | $8, 668 |
| Value per ton | $5. 50 |
| Total number of employés | 25 |
| Total wages paid | $3, 510 |
| Total capital invested and employed in business | $7, 250 |
| Capital invested in buildings and fixtures | $1, 250 |
| Capital invested in tools, implements, live stock, machinery, and supplies on hand | 1, 000 |
| Capital invested in other items, including cash | 5, 000 |

The production of manganese in Vermont in 1888 and 1889, the 2 years concerning which there is a report, was as follows:

PRODUCTION OF MANGANESE IN VERMONT IN 1888 AND 1889.

| | TONS. |
|---|---|
| 1888 | 1, 000 |
| 1889 | 1, 576 |

## VIRGINIA.

The production of manganese in Virginia in 1889 was 14,616 tons, which would grade as manganese ore proper. The statistics of this production are as follows:

### STATISTICS OF THE PRODUCTION OF MANGANESE IN VIRGINIA IN 1889.

| | |
|---|---|
| Total production (tons) | 14, 616 |
| Total value | $156, 257 |
| Value per ton | $10. 69 |
| Total number of employés | 171 |
| Total wages paid | $65, 939 |
| Total capital invested in lands, etc., and employed in business | $711, 000 |
| Capital invested in lands | $350, 000 |
| Capital invested in buildings and fixtures | 25, 000 |
| Capital invested in tools, implements, live stock, machinery, and supplies on hand | 175, 000 |
| Capital invested in other items, including cash | 161, 000 |

The production of manganese so far as has been ascertained, from 1880 to 1889, inclusive, was as follows:

### PRODUCTION OF MANGANESE IN VIRGINIA FROM 1880 TO 1889, INCLUSIVE.

| | TONS. |
|---|---|
| 1880 | 3, 661 |
| 1881 | 3, 295 |
| 1882 | 2, 982 |
| 1883 | 5, 355 |
| 1884 | 8, 980 |
| 1885 | 18, 745 |
| 1886 | 20, 567 |
| 1887 | 19, 835 |
| 1888 | 17, 646 |
| 1889 | 14, 616 |

It will thus be seen that there has been a gradual decrease since 1886, the year of the greatest production, when 20,567 tons were mined. The total production in Virginia in 1889 was not equal to the production of the Crimora mines in 1885, 1886, 1887, and 1888.

The production of the Crimora mines and the adjoining mine, the Old Dominion, which were worked as one, from 1886 to 1889, was as follows:

### PRODUCT OF THE CRIMORA MINES, VIRGINIA.

| | TONS. |
|---|---|
| Prior to 1869 | 5, 684 |
| May, 1869, to February, 1876 | 280 |
| February, 1876, to December, 1878 | 2, 326 |
| December, 1878, to December, 1879 | 1, 602 |
| 1880 | 2, 963 |
| 1881 | 2, 495 |
| 1882 | 1, 652 |
| 1883 | 5, 185 |
| 1884 | 8, 804 |
| 1885 | 18, 212 |
| 1886 | 19, 382 |
| 1887 | 19, 100 |
| 1888 | 16, 100 |
| 1889 | 12, 974 |

So far as explorations have been made, manganese ores have been found over a much greater extent of territory in Virginia than in any other of the United States. It is uncertain what future developments may prove, but Virginia has more known deposits of this mineral. They are spread over a greater extent of territory, more localities have been worked, and more manganese has been raised, and yet there were but 2 localities in this state, Crimora and Houston mines, from which any material amounts of manganese were produced in 1889. A small amount of a very high grade of pyrolusite for use in glass making and in the manufacture of bromine was shipped from a third mine, the Leets or Lemer mine, at Mount Athos. These three are the only regular producing mines in the state, and at present the Houston and Crimora are falling off in production.

In Virginia, as elsewhere, deposits of manganese almost invariably accompany those of iron. Where iron ores are abundant, more or less of manganese may be confidently looked for. At least 8 groups of the geological formations in Virginia are iron bearing; each of these contains more or less manganese. These iron ores are found in belts or bands, generally extending across the state in a northeast and southwest direction, following the strike of the outcrops of the rocks as a rule.

Many of the deposits opened in this state exhibit in a marked degree the uncertainties and risks of manganese mining, as well as the misleading character of "indications". Deposits that have promised remarkable results as well as large returns to their owners have proved in many cases to be pockets of small extent, producing at most but a few hundred tons of ore before exhaustion, and baffling all attempts to discover additional ore in their vicinity. In other deposits the ore will prove high in phosphorus or low in manganese, or so irregular in its content of mineral as to make selection difficult or uncertain and to forbid giving the guaranty of richness, and for some uses of the purity, which purchasers require. For obvious reasons, therefore, it has not been possible in every case to ascertain the exact facts as to the character or the present condition of the deposits discussed. The statements made must be regarded as giving the best information available. They are made "on authority", and are in but very few cases the results of personal examination.

In discussing the manganese deposits of Virginia it will be more convenient to arrange them in accordance with the natural divisions of the state. These divisions are: (1) Tidewater; (2) Midland; (3) Piedmont; (4) Blue Ridge; (5) Valley; (6) Appalachia; (7) Transappalachia.

Some manganese has been found in pockets of small extent in the Tidewater sections of Virginia. One deposit near City Point yielded some hundreds of tons of ore before it was exhausted, and it is reported that others have been worked. No deposits of such extent as that at Crimora can be expected in this region, though it is probable that small pockets will be found in connection with the beds of iron ore that outcrop in the bluffs along the banks of the rivers. The age of these deposits is much later than that of those found resting on the potsdam in the Valley district, the iron ore with which it is associated being found in the tertiary, chiefly in the miocene.

In the Midland district of Virginia deposits of manganese become more abundant, this division, with the Valley, furnishing practically all the manganese mined in the state. The ore that has been mined is found chiefly in Campbell, Nelson, and Pittsylvania counties, though there are deposits in Spottsylvania, Louisa, Appomattox, and perhaps other counties. The deposits are found in the extreme western part of the section, well up to the base of the mountains that form the dividing line between this and Piedmont; indeed, it is possible that some of these deposits should be classed in Piedmont, but as they are all situated on the same belt as Campbell county they are classed in Midland.

The Mount Athos mine, which probably produces the highest grade of manganese mined in the United States, is in Campbell county, just across the line from Appomattox county, near Mount Athos station, on the Norfolk and Western railroad, just where the James river turns to the north. It is one of the few deposits on the right bank of the James. This mine is sometimes known as the Leets mine.

The manganese is found in pockets associated with iron ore, and also as button ore in a dark-colored micaceous schist, 8 feet thick, holding some 40 per cent of nodules, varying in size from a bean to that of an oyster. Analyses of this ore are as below:

ANALYSES OF MOUNT ATHOS, VIRGINIA, MANGANESE ORES.

| COMPONENT PARTS. | No. 1. | No. 2. | No. 3. |
|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* |
| Metallic manganese | 43.580 | 45.870 | 44.180 |
| Metallic iron | 5.240 | 5.340 | 6.640 |
| Phosphorus | 0.316 | 0.257 | 0.274 |
| Silica | 7.150 | 7.770 | 7.730 |

Some of the ore is much better than these analyses, showing 48 to 50 per cent and even more of metallic manganese. That selected for use in glass making is even higher than this.

Some manganese has been mined at the Bishop mine, Lynch station, Campbell county, which seems to be a continuation of the Mount Athos mine, and also at Leesville, in the same locality.

In Pittsylvania county, southwest of the Mount Athos deposit, a manganiferous iron ore with the following analyses has been found:

ANALYSES OF MANGANIFEROUS IRON ORE FROM PITTSYLVANIA COUNTY, VIRGINIA.

| COMPONENT PARTS. | No. 1. | No. 2. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Metallic manganese | 24.780 | 27.860 |
| Metallic iron | 29.860 | 28.140 |
| Phosphorus | 0.362 | 0.347 |
| Silica | 7.020 | 4.320 |

The deposit is but a quarter of a mile distant from the Virginia Midland railroad.

In Nelson county several deposits of manganese have been worked quite extensively in past years, though no ore is now mined. These deposits are found in the ore belt of the James river, already described, the belt running nearly parallel to the river and about 2 miles from the left or northwestern bank. The manganese shows generally in small quantities on the surface, the deposit widening as it goes down. The manganese is found in pockets, and usually in clay.

From what is known as the Cabell mine, 2 miles from Warminster depot, on the Richmond and Alleghany railroad, some 5,000 tons of manganese were taken in 1868 and 1869 by Mr. James E. Mills, who was employed by a Newcastle (England) firm, and shipped to Newcastle-on-Tyne, and who probably made the first systematic search for manganese in the United States, unless Mr. Sibert's mining in the valley of Virginia may be termed systematic. The mine has not been worked since 1871. An analysis of the ore showed 82.25 per cent of manganese peroxide.

Two other analyses gave the following:

ANALYSES OF MANGANESE ORES FROM CABELL MINE, VIRGINIA.

| COMPONENT PARTS. | No. 1. | No. 2. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Metallic manganese | 44.300 | 43.020 |
| Metallic iron | 3.670 | 4.240 |
| Phosphorus | 0.243 | 0.182 |
| Silica | 17.450 | 18.510 |

About half a mile southwest of the Cabell mine is a deposit known as the Bugley mine, which was worked about the same time and yielded about 2,000 tons of ore.

At Midway Mills is a deposit, on the land of Mr. G. F. Simpson, which was worked in 1882 and yielded some 1,200 tons of first-class ore. The mine was worked by shaft to the depth of 165 feet, when it was drowned out. The ore above the water line is said to have shown some 70 per cent oxide, but below the line it was much richer, 80 to 85 per cent. The entire product was marketed in Liverpool.

At the Davis mine, in Nelson county, an ore giving from a picked specimen the following analysis was at one time mined, though operations are now suspended:

ANALYSIS OF MANGANESE ORE FROM NELSON COUNTY, VIRGINIA.

| | PER CENT. |
|---|---|
| Manganese binoxide | 90.42 |
| Iron sesquioxide | 2.24 |
| Alumina | 1.13 |
| Lime | 1.22 |
| Magnesia | 2.28 |
| Silica | 1.12 |
| Phosphoric acid | 0.43 |
| Water | 1.25 |
| Metallic manganese | 57.16 |
| Metallic iron | 1.56 |
| Phosphorus | 0.19 |

Some 1,000 tons have been taken from this mine. Deposits are also reported in Appomattox and Amherst counties.

No details have been obtained concerning the manganese ores of the Piedmont and Blue Ridge districts. The deposits are small and of no commercial value.

The chief sources of the manganese produced in this state and in the country are the mines of the valley of Virginia, or, as it is sometimes called, the Shenandoah valley. In this valley are located the Crimora mines, that have produced as much ore as the entire country besides, and the Houston mines. The manganiferous belt lies along the western base of the Blue Ridge, on the eastern side of the valley. It is asserted that this belt extends 300 miles in the state, and that workable beds of manganese ore have been found in every one of the 12 valley counties that abut on the western foot of the Blue Ridge.

It is along this belt that the remarkable body of iron ore accompanying the potsdam or No. I formation of Rogers is found, and with this iron the manganese ores are associated. Indeed, it is in the clays formed by the decomposition of the ferriferous shales of the potsdam that the ore is usually found imbedded. An exception to this is noted by Professor William M. Fontaine, in his "Notes on the mineral resources at certain localities in the western part of the Blue Ridge", as occurring on the lands of Joshua Robertson, some 5 miles from Waynesboro. The ore at this point, which is psilomelane, occurs in the primordial formation in a fissure in a cracked and crushed band of the upper gray shales and flags, and has impregnated the walls, which are kaolin flags. Some 100 tons were taken from this locality in 1857 by a Mr. Sibert. Professor Fontaine is of the opinion that the origin of this manganese is similar to that of the iron ore occupying a similar geological position, viz, deposition in disturbed beds from solution in water.

Manganese mining began in this state and district as early as 1859, a Mr. Sibert having made thorough explorations through the whole extent of the valley, opened up quite a number of deposits, and shipped the product to England for chemical purposes. Mr. James E. Mills, who was employed by a Newcastle (England) firm, also did some mining in this district, though his chief work in production was done at the Cabell mine, in the Midland district.

The most important deposits of manganese and manganiferous iron ores in the valley of Virginia and in the state in production are those at Shenandoah, in Page county, at Crimora, including the Old Dominion mine, in Augusta county, and the Houston mines, in Botetourt county. There are other deposits which will be referred to, but these 3 are the notable ones. As the Crimora mines are described in the discussion on the "Origin and occurrence of manganese", in another part of this report, it will not be necessary to repeat what was there said.

Considerable quantities of manganese and manganiferous iron ores have been taken from the iron-ore mines at Shenandoah, formerly called Shenandoah iron works and mines, in Page county. The average analysis of the shipments of 1885 was as follows:

ANALYSIS OF MANGANIFEROUS ORES FROM PAGE COUNTY, VIRGINIA.

| | PER CENT. |
|---|---|
| Metallic manganese | 28.00 |
| Metallic iron | 17.00 |
| Phosphorus | 0.15 |

Ore of a much higher grade has been found there, and considerable ore mined and in sight, but none is being sold at present. The ore is found in a wash or drift deposit associated with brown hematite. The deposit is quite irregular and uncertain. This range of ore lies along the eastern foot of the Blue Ridge, and evidently contributed to the Crimora basin, which is in this range.

From a deposit on what is known as the Garrison tract, the top of which is a fine ore, but which becomes coarser and harder as it goes down, Mr. A. S. McCreath took samples which gave the following analyses:

ANALYSES OF MANGANESE ORES FROM THE GARRISON TRACT, VIRGINIA.

| COMPONENT PARTS. | Fine ore. | Lump ore. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Metallic manganese | 52.691 | 53.656 |
| Metallic iron | 2.325 | 1.537 |
| Phosphorus | 0.324 | 0.327 |
| Silica | 27.950 | 1.955 |

A manganiferous iron ore is found in the Kimball bank, lying 3 miles east from Shenandoah. This bank consists of 2 openings, the Atwood and Bolan, the Atwood carrying the larger proportion of manganese. A sample of these ores mixed (two-thirds Atwood and one-third Bolan) showed the following analyses:

ANALYSIS OF MANGANESE ORE FROM KIMBALL BANK.

| | PER CENT. |
|---|---|
| Metallic iron | 40.875 |
| Metallic manganese | 7.349 |
| Phosphorus | 0.084 |
| Siliceous matter | 15.440 |

Another analysis of the ore by Bowron gives—

| | PER CENT. |
|---|---|
| Sesquioxide of iron | 70.00 |
| Manganese oxide | 13.31 |
| Silica | 4.73 |
| Alumina | 0.86 |
| Water | 11.02 |
| Phosphorus | Mere trace. |

The Lyndhurst deposit was opened by Mr. Sibert in 1859. He sunk a shaft, striking the ore deposit at the depth of 45 feet. From the bottom of the shaft a drift was driven some 20 feet. Upward of 250 tons of ore were taken from the shaft and drift and shipped to London. Analyses of the ore recently taken from this shaft are as follows (J. Blodgett Britton, chemist):

ANALYSES OF MANGANESE ORE FROM HEISERMAN'S FARM, AUGUSTA COUNTY, VIRGINIA.

| COMPONENT PARTS. | No. 1. | No. 2. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Peroxide of manganese | 93.06 | 86.77 |
| Peroxide of iron | Trace. | 2.98 |
| Silica | 0.18 | 3.98 |
| Alumina | 0.91 | 2.81 |
| Baryta | 2.81 | 0.31 |
| Water (total) | 2.75 | 2.93 |
| Lime | | Trace. |
| Not determined and loss | 0.29 | 0.22 |
| Total | 100.00 | 100.00 |
| Available peroxide | 92.54 | 86.62 |

The old shaft was destroyed and filled up by a flood, a very common occurrence apparently in this section. The new shaft is located above the flood level. Near this is a deposit showing manganese in process of formation into lumps.

The Kennedy tract, a well-known manganese deposit, is 3 miles from Stuarts Draft station, on the Shenandoah Valley railroad. This is another of the deposits opened up by Mr. Sibert. It takes its name from the old Kennedy furnace, built early in the present century, and adjoins the lands of the more recent Mount Torrey furnace. Mr. Sibert is reported to have mined some 100 tons of the ore in 1859. In 1872 a Mr. Armstead dug some pits, searching for iron ore, and is reported to have discovered at a depth of 20 feet a bed of psilomelane. Ore taken from this opening shows from 30.52 to 43.30 per cent of manganese.

A complete analysis is as follows:

ANALYSIS OF MANGANESE ORE FROM KENNEDY TRACT.

| | PER CENT. |
|---|---|
| Metallic manganese | 43.300 |
| Metallic iron | 3.880 |
| Sulphur | 0.083 |
| Phosphorus | 0.052 |
| Barium | 6.930 |

The ores occur both as manganese ores and as manganiferous iron ores. At one point it is in bands and films one-fourth of an inch in thickness, the ore being nodular in form and inclosed in clay from the ferriferous shales.

At Blue bank, at the Fauber mines, at the Newton mine bank, at the Kelly bank, and several banks on the Big Mary creek, all in the neighborhood of the old Cotopaxi and Vesuvius furnaces, which have been abandoned for some years, manganese and manganiferous iron ores have been found and mined to some extent. These deposits are all near the line of the Shenandoah Valley railroad and near the line separating Augusta and Rockbridge counties. The Blue bank was opened to supply the Cotopaxi furnace, but it had too much manganese in it to be used as an iron ore, and the working was abandoned. The Fauber mines were opened by Mr. Sibert, who took from them some 75 tons of manganese, it is said. The deposit is psilomelane in nodular masses and lumps in clay. The Newton mine bank is in a steep ridge near the headwaters of the south James river. Sometimes the ore from this mine is a quite pure oxide of manganese, and again only a manganiferous iron ore. The deposit is quite large, a section showing one of the two veins to be 36 feet wide, composed of alternate deposits of hematites, mixed iron and manganese, and manganiferous iron ore. An analysis of a sample of the ore, 143 pieces taken from along the face of the open cut, made by Mr. McCreath, shows:

ANALYSIS OF MANGANESE ORE FROM THE NEWTON MINE BANK.

| | PER CENT. |
|---|---|
| Metallic iron | 41.125 |
| Metallic manganese | 8.221 |
| Phosphorus | 0.265 |
| Siliceous matter | 14.830 |

The Kelly bank is part of the property of the old Vesuvius furnace, and is situated in Rockbridge county. Both iron ores and manganiferous ores are found, the latter lying nearer the potsdam than the former. Much of the ore consists of iron and manganese mixed, the manganese forming layers and films in the iron.

On Big Mary creek manganese has been found at several openings, and surface indications of other deposits are abundant. Here the same conditions exist as at the Kelly bank, some of the manganese being quite pure and some mixed with iron. The richest manganese shows some 47 per cent of the metal to 6 per cent of iron.

The Houston mines are near a station of the same name on the Shenandoah Valley railroad, in Botetourt county. Some of the ore mined here exceeds 44.25 per cent of manganese, but the average is less than this. A large washing and separating plant has been erected at these mines and very extensive and expensive developments undertaken. The ore occurs in pockets next to iron ore, and examination indicates that the deposit is a large one. About two-thirds of the ore is lump, the rest is quite fine. A selection of 115 pieces to represent the iron ore and 68 pieces to represent the manganese gave Mr. McCreath, upon analysis, the following results:

ANALYSES.

| COMPONENT PARTS. | Iron ore. | Manganese ore. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Metallic manganese | 7.277 | 44.312 |
| Metallic iron | 47.150 | 12.325 |
| Phosphorus | 0.061 | 0.101 |
| Siliceous matter | 8.030 | 5.470 |

ANALYSIS OF A SAMPLE OF SELECTED ORE.

| | PER CENT. |
|---|---|
| Metallic manganese | 59.870 |
| Metallic iron | 0.500 |
| Phosphorus | 0.049 |
| Silica | 2.300 |

AVERAGE ANALYSIS OF THE MONTHLY SHIPMENTS FOR 1884 AND 1885.

| | PER CENT. |
|---|---|
| Metallic manganese | 39.000 |
| Metallic iron | 12.000 |

The highest monthly average was 45 per cent metallic manganese; lowest, 31 per cent; phosphorus, about 0.07 per cent.

The manganese deposits at this mine lie well up on the west slope of the Blue Ridge range. No. 4 opening is situated on the northwest slope, and just at the foot of a branch ridge separated by a narrow valley, not over 50 feet wide, from another ridge, which lies to the west, and parallel with the ridge in which No. 4 is found. This No. 4 opening is about 1,250 feet above tide water at Richmond, 400 feet above the drainage level of the surrounding country. The deposits of manganese appear from end to end of the tract, which is worked for two-thirds of a mile in length. The ore line runs northeast to southwest, 35 north of east. The manganese occurs in pockets, usually in a tough yellow clay, sometimes next to a fine red sand. Occasionally nests or pockets of the purest manganese are found, yielding 100 to 150 tons of ore in lumps the size of an egg and smaller, and so clean as to require no washing.

At No. 4 opening the principal pocket of manganese lies just above and against the potsdam sandstone, which is here massive and hard. Much of this sandstone, when blasted and shattered, shows very beautiful specimens of pure manganese adhering most tenaciously to the stone. The slates or shales are found to the northwest of the ore line and at the base of the foothills of the Blue Ridge, half a mile from the clays that carry the ore deposits. Adjacent to these the limestone stretches away to the northwest.

Southward from the Houston mines, in the same range, Mr. J. T. Chapman has a deposit of manganese which gave the following:

ANALYSIS OF MANGANESE ORE FROM THE CHAPMAN DEPOSIT, BOTETOURT COUNTY, VIRGINIA.

| | PER CENT. |
|---|---|
| Metallic manganese | 45.800 |
| Metallic iron | 3.060 |
| Phosphorus | 0.164 |

In Smyth county, on the south fork of the Holston river, in Rye valley, the ore shows at times considerable manganese. Mr. McCreath's analysis of a sample of 133 pieces gave:

ANALYSIS OF MANGANESE ORE FROM THE RAZOR BANK, SMYTH COUNTY, VIRGINIA.

| | PER CENT. |
|---|---|
| Metallic manganese | 10.181 |
| Metallic iron | 40.100 |
| Phosphorus | 0.536 |
| Siliceous matter | 10.520 |

Some 6 miles from Seven Mile Ford station, on the Norfolk and Western railroad, on what is locally known as Chestnut ridge, several openings have been made, showing a rich grade of manganese ore, from which some ore has been taken for trial.

Near Marion, Smyth county, on the east flank of Glade mountain, is a large deposit of manganese, associated with a good brown hematite, which is found in large masses in this region. The deposit has been traced for 8 miles along the outcrop. Large bowlders of the manganese are found, some weighing over half a ton.

The following analysis shows the character of the ore:

ANALYSIS OF MANGANESE ORE FROM NEAR MARION, SMYTH COUNTY, VIRGINIA.

| | PER CENT. |
|---|---|
| Metallic manganese | 9.910 |
| Metallic iron | 45.320 |
| Phosphorus | 0.086 |
| Silica | 1.760 |

Some of the manganese ores in Pulaski and Wythe counties are found in the oriskany rocks, the lower member of the devonian, as the potsdam, in connection with which so much manganese is found in this valley, is the lower member of the silurian. The oriskany ores in this section are usually of a much higher grade than the ores of the potsdam in the same region. The ores are at times brown hematites of a high grade, at others manganese, and at still others nothing but a ferruginous sandstone.

In that portion of Virginia known as Appalachia, which includes the broken mountainous country between the Valley district and West Virginia, quite a number of deposits of manganese ore, some quite high in manganese and of a good quality, are known to exist. Most of these are so situated with reference to transportation routes, however, that they are not available at present.

The manganese ores in this portion of Virginia are, as a rule, of a later geological age than those of the Valley district. The Valley ores are usually found in connection with the Potsdam No. I of Rogers' survey. Those of the Appalachia are found in the Hudson River No. III, the Clinton No. V, and especially in the Oriskany No. VII. In all cases the manganese is associated with iron ores, usually brown hematites, sometimes as a manganiferous portion of an iron ore, at others as a manganese ore. Little or no ore has been mined in this district, though at places the indications for large deposits are favorable. In the southwest corner of Frederick county is a deposit of manganese, known as the Paddy Mills manganese mine, which has produced some manganese in past years. The mine is a conical shaped hill, covering about a square mile, and rising to a height of some 150 feet above the drainage level of the surrounding country. The ore is found in connection with the limestone and imbedded in the strata. The deposit is somewhat unreliable, being cut off by the limestone. The ore is chiefly soft pyrolusite; part of it, however, is hard, running about 50 per cent metallic manganese, 4 per cent iron, and from 0.09 to 0.10 per cent of phosphorus. There have been removed from this mine some 2,000 tons of ore, mostly before the war, and by very imperfect methods of mining. No shaft has gone below 50 feet, so that it is not known how large the deposit is. Should it extend downward considerable ore might be found. The ore requires washing, for which there is plenty of water.

At Van Buren furnace, in Shenandoah county, in connection with the iron ores a valuable and extensive deposit of manganese is found. This was at one time worked extensively, very large amounts being shipped before the war, but no mining has been done for 12 years, owing to the lack of transportation facilities, there being no railroad station nearer than Woodstock, 9 miles distant. The ore occurs in pockets, but they seem to be continuous, and can be traced on the surface for more than 3 miles. The washed ore analyzes upward of 70 per cent oxide. In a description of the Van Buren furnace property, on which this deposit is located, Major Jed. Hotchkiss makes the following statement regarding manganese:

> Manganese has been mined in considerable quantities from the mine located at the western end of Cupola mountain, where, as is very often the case in Virginia, it accompanies the outcrop of No. VII (oriskany), the backbone of that mountain. It outcrops also in the broken hills that prolong Cupola to the southwest; it also shows in places along the iron-ore outcrops of Tea, Little North, and the eastern slope of Paddy mountains, where, no doubt, large pockets of this valuable mineral will be found in the stratified iron-ore beds, locally taking the place of the iron ore, as is often the case in the Clinton beds in Virginia.

Considerable attention has recently been directed to what is known as the Powells Fort manganese mines, located at Powells Fort, in Shenandoah county, on the Northeast Massanutton mountain. This mine has been worked at times for many years. The property is owned by the Manganese and Iron Company of Baltimore, and contains 531 acres, immediately between Three Top mountain to the north and Green mountain to the south. This system runs northeast and southwest, conformably with the universal belt of the Appalachian chain. The following statement is furnished by the company:

> There are 2 parallel veins over 1 mile in length, only 1 of which, however, is developed. The mines have been operated at intervals for several years in a crude manner and on a very small scale. During this time considerably over 1,000 tons of ore were shipped. One of the most celebrated manganese experts in the United States carefully examined this property and advised its purchase by the company, as it was the only well-defined vein he had ever seen, the walls being perfectly regular, the hanging conglomerate, the foot wall sandstone. The vein varied in width from 4 to 7 feet, traceable from one boundary of the property to the other by its bold outcrop, which has been opened at several places, showing well everywhere.

The ore is remarkably clean, almost entirely free from foreign matter. It is highly crystallized, very soft, a genuine pyrolusite of high grade, and is nearer chemically pure than any yet found, as will be seen by reference to the following analyses:

ANALYSES OF MANGANESE ORE FROM POWELLS FORT, SHENANDOAH COUNTY, VIRGINIA. (*a*)

FIRST ANALYSIS.

| | PER CENT. |
|---|---|
| Oxide of manganese (*b*) | 94.30 |
| Moisture | 0.28 |
| Insoluble siliceous matter | 1.78 |
| Alumina | 1.10 |
| Baryta | 1.30 |
| Sesquioxide of iron, lime, and manganese | 0.50 |
| Undetermined matter | 0.74 |
| Total | 100.00 |

*a* By J. Blodgett Britton, of Philadelphia.

*b* Nearly all binoxide. By the analysis it should be taken as a fully 90 per cent binoxide.

ANALYSES OF MANGANESE ORE FROM POWELLS FORT, ETC.—Continued.

SECOND ANALYSIS. ([a])

| | PER CENT. |
|---|---|
| Silica in the form of quartz | 3.78 |
| Peroxide of iron | 0.43 |
| Metallic manganese | 60.66 |
| Oxygen with manganese, undetermined matter, and loss | 34.09 |
| Alumina | 0.25 |
| Moisture | 0.37 |
| Baryta | 0.42 |
| Total | [b]100.00 |

[a] By J. Blodgett Britton.

[b] By the analysis it should be taken as a fully 90 per cent binoxide.

On what is known as the Guy Run estate, in Rockbridge county, 6 miles southward from Goshen Bridge station, on the Chesapeake and Ohio railroad, quite an extensive deposit of manganese has been discovered. Up to the present time but a few tons have been mined. In its general topography this estate is quite mountainous. The ores are found in the valleys. The manganese lies in close proximity to Rogers No. VII (oriskany) brown hematite ores, imbedded in potters clay, which separates it from the iron ore. It is in pockets more or less persistent along the line of the ore horizon of No. VII.

ANALYSIS OF SAMPLES OF SOLID ORE FROM GUY RUN ESTATE, ROCKBRIDGE COUNTY, VIRGINIA.

| | PER CENT. |
|---|---|
| $Mn_3O_4$ | 89.67 |
| $Fe_2O_3$ | 4.30 |
| Sulphuric acid | 1.25 |
| Silicic acid | 0.79 |
| Metallic manganese | 64.59 |
| Metallic iron | 3.01 |
| Phosphorus | 0.55 |

In the counties of Appalachia, southward of those already named, many outcrops and other indications of manganese are found. Most of these are now too far from railways to be profitably worked.

At Panther Gap some ore has been mined, though no statement as to amount or the character of the deposit was obtained.

In Craig county several manganese deposits have been opened, but the distance from railroads precluded shipments for a long time. The Craig Valley branch of the Chesapeake and Ohio railroad will give transportation facilities and possibly lead to the development of these ores. These deposits are stated to extend a distance of 17 miles.

Analyses are as follows:

ANALYSES OF MANGANESE ORES FROM CRAIG COUNTY, VIRGINIA. ([a])

| COMPONENT PARTS. | No. 1. | No. 2. | No. 3. | No. 4. | No. 5. |
|---|---|---|---|---|---|
| Metallic manganese | 45.000 | 52.420 | 49.480 | 53.060 | 50.500 |
| Metallic iron | | | 6.830 | 1.820 | 4.810 |
| Phosphorus | 0.085 | 0.303 | 0.063 | 0.058 | 0.026 |
| Sulphur | | | 0.010 | | |
| Silica | 4.700 | 0.460 | 2.530 | 1.670 | 0.580 |

[a] Nos. 1 and 2 by T. T. Morrell, chemist of the Cambria Iron Company; No. 3 by S. P. Sharpless, Boston; Nos. 4 and 5 by Vulcan Steel Works, Saint Louis.

In Giles county, in the oriskany measures, the iron ores often give way to manganese. Boyd, in his Resources of Southwest Virginia, says:

> In one point on these rocks (oriskany) on Flat Top mountain, near the line between Giles and Bland counties, the ore was found in great purity, containing valuable quantities of manganese disseminated heavily through sandstone.

Analysis of this ore shows 59.215 per cent metallic manganese. Manganese is also found in the Buckeye and Spruce river mountains and at the ore beds of the Sinking creek furnace, as well as at other localities in the county.

In Pulaski county manganese ores of a high grade are found among the oriskany iron ores of Walkers mountain.

The same is true of the extension of these mountains into Wythe county. The manganese ores found in the oriskany rocks of Big Walkers mountain, in Wythe county, are at times quite pure.

In Bland county the oriskany measures in several of the parallel mountain ranges that traverse the country from northeast to southwest show deposits of manganese ores of considerable extent and at times quite pure.

In Tazewell county surface indications are quite frequent, but the developments are not as yet sufficient to give an idea as to the extent of the deposits. Some of the specimens indicate rich and valuable ores.

In Smyth county there are frequent indications of manganese. At one, on the property of Mr. William Alexander, near Holstein Mill, the ore is in bowlders varying in weight from 2 to 300 pounds. Some 20 tons have been taken out at a depth not exceeding 6 feet. An analysis showed 62.57 per cent black oxide of manganese.

## HISTORY.

The black mineral known in commerce as "manganese", but which is really an oxide of the metal ($MnO_2$), was used in the arts many centuries before the beginning of the Christian era. Its earliest uses seem to have been in pottery manufacture and as coloring matter in the manufacture of glass. Analyses of Egyptian and Roman glass show as high as 2 per cent of manganese, and there seems to be no doubt that many preserved specimens of purple and pink glass owe their coloring to the presence of manganese. In later years it has been used both as coloring matter and as a decolorizer in glass making, it giving some of the most beautiful tints to glass, especially purples and pinks. On the other hand, it is used in small quantities in all glasshouses to remove the greenish tinge due to the presence of iron in the glass sand. It is this use of manganese that has given to it the name of "glass makers' soap" (savon de verriers).

In 1740 manganese was regarded as an ore of iron. In that year the chemist Pott pointed out that it frequently contained but the merest traces of iron. In 1771 Scheele began a careful chemical examination of it, and proved conclusively in his now well-known dissertation, published in 1774, that it was only an oxide of some metal which he could not produce in a metallic state. It was while engaged in the unsuccessful attempt to reduce this oxide that he made his valuable discovery of chlorine, and it is in the manufacture of this gas for use in the production of bleaching powder that manganese to-day finds one of its chief uses.

Dr. Gahn, a little later than Scheele, in 1774, succeeded in reducing the oxide to its metallic state, and Rinman in the same year pointed out the peculiar effect of manganese on the magnetism of iron, depriving it, when used in quantities in the manufacture of iron, of its usual magnetic property. In 1799 Reynolds attempted to use oxide of manganese in the production of steel, but was unsuccessful, it being reserved for Heath in 1839 and for Mushet some 15 years later to point out the great importance of this metal in the manufacture of crucible and bessemer steel, respectively. It is also true that in the manufacture of the celebrated Indian steel known as "wootz", which probably gives the finest cutting edge of any steel produced, a manganiferous pig iron is used. In later years Mr. Robert Hadfield, of Sheffield, England, has shown the important influence of manganese in large quantities in rendering steel both hard and tough.

It should also be pointed out that as early as 1830 Mr. David Mushet produced ferro-manganese, 35 years before it was produced in a commercial way by Henderson at Saint Rollox chemical works at Glasgow. Spiegeleisen, which is a pig iron containing varying proportions of manganese up to in some cases 30 per cent or higher, had also been produced in its lower percentages in Germany and the United States. But little use had been made of it, however, until Mushet pointed out its value as a recarburizer in the manufacture of bessemer steel. While excellent cast steel had been made before Heath's time, and while it was possible to produce bessemer metal by Bessemer's original process of leaving unoxidized in the converter an amount of carbon sufficient to give proper temper to the steel, it nevertheless is a fact that steel has been produced better and cheaper by the use of Heath's and Mushet's inventions than would have been possible by the processes in use before their time.

In 1785 Berthollet pointed out the use of chlorine as a bleaching agent, which, as stated above, had been discovered by Scheele in his experiments on manganese ore in 1774. Its use was introduced into Glasgow as early as 1789 by Watts, a celebrated engineer, and thence found its way to Lancastershire. The chlorine was produced by the action of hydrochloric acid on the binoxide of manganese. At first chlorine was used by the saturation of water with the gas, but it was found that the alkali would soon absorb more chlorine than water; hence the production of bleaching powder. For many years, and until the demand for spiegeleisen and ferro-manganese, by far the largest percentage of the production of manganese was used in chemical works for the production of chlorine. The use of manganese at the present time in these works is not as great in proportion to the amount of bleaching powder produced as formerly, methods for recovering manganese from the waste having been discovered.

## ORIGIN AND OCCURRENCE OF MANGANESE.

From the close association in which iron and manganese are usually found it is probable that they have the same origin. It is not within the limits of this report to discuss the various theories that have been advanced regarding the origin of iron ores. This is done very thoroughly in Winchell's Iron Ores of Minnesota. It is evident, however, that in many parts of the United States the manganese nodules, which form the bulk of the ores, were imbedded in ferriferous shales, and the tenacious clay in which the manganese in many parts of Virginia is found imbedded was formed by the decomposition of this clay. In Arkansas a nodular ore of manganese is found imbedded in an undecomposed shale.

Manganese is usually found in pockets like its cousin-german, brown hematites, usually imbedded in clay and requiring washing. The clays in the horizon of the ferriferous shales are colored brown from the diffused manganese, while the clays of the deposit in which the manganese is most abundant are red, showing that the gathering of the manganese into masses has left the iron predominant.

The ore occurs as shot ore and in nodules, lumps, and masses, from the size of a pin head to masses weighing tons. "Sheets" of ore are sometimes formed by the union of masses that lie in a uniform direction. These masses are evidently concretionary in their origin. The masses are not only incased in clay, but they often inclose clay. Near Lyndhurst station, Virginia, on the Shenandoah Valley railroad, manganese in the process of formation into lumps has been observed. The ore is psilomelane, with some pyrolusite and manganite, the softer material being found in cavities of the material or forming seams in the harder ore. Lumps and crusts of the manganese may be seen imbedded in the clay, and they are plainly now in process of formation. The manganese seems to be freely diffused through the dark-brown umber and to be gradually concentrated out of the clay in lumps and crusts. In some cases crusts of manganese may be seen inclosing the clay, and the nodules often show inclosed clay.

The base of the Virginia deposits in the Blue Ridge is usually the potsdam; that of the Appalachian district is the Hudson River No. III, Clinton No. V, and Oriskany No. VII.

In the Cartersville (Georgia) district the ore occurs in pockets imbedded in a drift deposit, usually covering hilltops and outcropping, but at times at a depth of from 3 to 30 and even 100 feet below the surface. These deposits are at times bedded with some regularity and at others scattered without the least regularity. There are frequently "leads" running from one deposit to another. The drift in which the ore is imbedded varies greatly, being sometimes ocher, at others a blue dirt, soft and without grit, and at still others it is said to be found in sand rock. These deposits have as their base the silurian rocks, usually the potsdam, and lie near the metamorphic rocks of the state. They are associated with limonite deposits of a similar character, the limonite usually occurring to the west of the manganese.

The ore occurs as massive, crystallized, and needle ore, and is found in grains from the size of a mustard seed to that of a pea and even a walnut, and also in much larger masses.

In Batesville (Arkansas) district it is stated that the ores occur in two horizons and under two distinct conditions:

1. The drift ores of the northwestern portion of the region.
2. The regular stratified bed of the eastern portion of the belt.

The drift manganese ore is found under the tops of the hills in pieces from the size of a pea up to bowlders 2 and 3 and even 4 tons in weight. The diluvian deposit carrying the ore is from 5 to 25 feet in thickness, averaging, say, 9 feet, and rests upon a floor of limestone, a brown clay of varying thickness being interposed. This ore drift yields from 12 to 30 per cent of ore. Above the manganese drift is an earthy wash, interspersed with fragments of chert from 3 to 30 feet thick. At the Southern mine the stripping is 2 to 25 feet thick, and the drift in which the manganese is found 20 feet thick. The pit at this mine covers a little more than half an acre. At other pits opened the stripping is 10 feet and the ore drift 5 to 11 feet.

The source of the manganese ore lumps is believed to be the "cavernous limestone" found to the northwest of the ore belt, which originally occupied greatly elevated positions. Some of the formation near the mouth of Lafferty creek which has escaped the denuding agencies still carries veins of manganese ore 8 to 14 feet thick.

In Nova Scotia the ores of manganese, which are usually of a very high grade, occur most abundantly in the lower carboniferous marine limestone, though some ores are found in the lower silurian.

The carbonate manganese ore of Great Britain is found in truly stratified beds in the cambrian rocks of Merionethshire.

No information is at hand regarding the occurrence of the manganese ores of Chile or Russia, the two chief sources of supply. What information has been secured regarding the deposits in these countries, as well as in Greece, Turkey, Italy, France, Russia, and elsewhere, will be given under appropriate heads.

As the Crimora mine, in the Shenandoah valley of Virginia, is the most important manganese mine in this country, if not in the world, a description of the mine and the mode of occurrence of the manganese will be of interest. (*a*)

The Crimora mine, the property of the American Manganese Company, limited, is situated in Augusta county, Virginia, 2.5 miles from Crimora station, on the Shenandoah Valley railroad, with which it is connected by a branch road.

The ore deposit, which is most peculiar in its location and accumulation, occurs in an elliptical basin about 500 feet broad on its transverse axis and 800 to 900 feet long. This basin is cut out of the potsdam sandstone, which is at this place hard rock. Opposite to the basin and at a right angle to its longer axis is a deep ravine, Turks gap, sharply cut into the flanks of the mountain, through which a stream flows. Nearly opposite to this ravine is a ridge that served as a bulwark to the action of the forces at work in this section. Evidently this basin is the work of old time eroding agencies, acting just as water now acts below a river dam, excavating a deep curved section. The formation and location of this basin, as well as the deposit it contains, is exceedingly interesting and peculiar.

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*a* For much of this description and the cuts credit is due to an article in the American Manufacturer and Iron World, and to a paper read before the American Institute of Mining Engineers by Charles E. Hall.

The basin is filled with wash and manganese ore lumps. The general body mixture, the mud, sand, and clay, with the lumps of manganese ore, were carried to place by agencies more recent than those which excavated the basin, just as the iron-ore pits in the limestone valleys of Pennsylvania were filled in.

There are 2, possibly 3, special layers of yellow clay, which are rich in lumps and masses of ore, the lower about 30 feet in thickness, the upper about 25 feet thick. A layer of clay 20 feet thick, almost barren of manganese ore, separates these 2 ore-bearing layers. The mining operations are at present confined to these beds.

The ore is found in lumps and masses, from the size of a small pebble to lumps weighing a quarter of a ton or more. One mass was found which was 115 feet by 60 feet and 50 feet high. These lumps are found scattered through the basin, as above indicated, and cover an area of about 6 acres. The basin at the shaft is 117 feet deep. Some "sheets" of ore formed by the union of masses that lie in a pretty uniform direction are also found. The larger masses are blasted in the mine.

Fig. I.

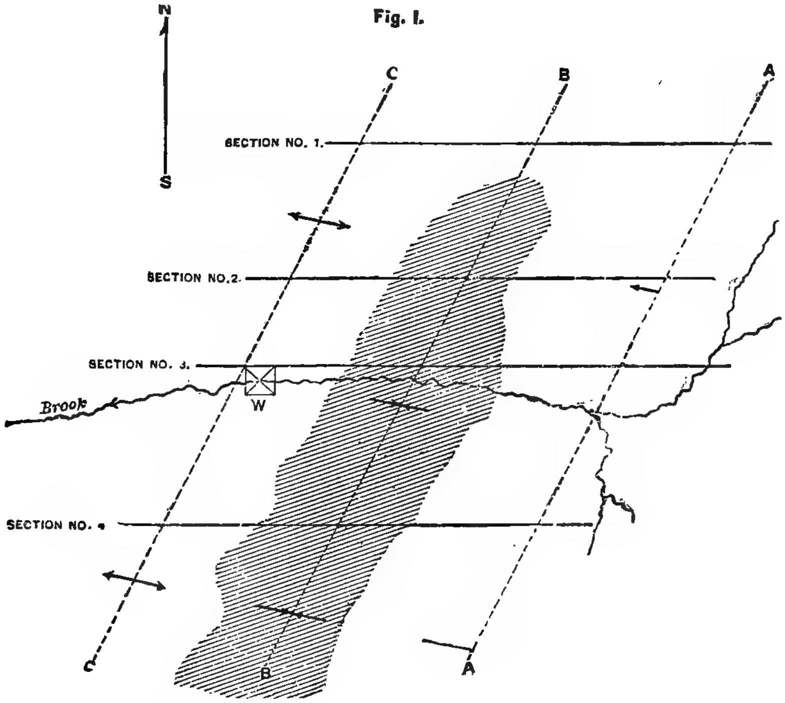
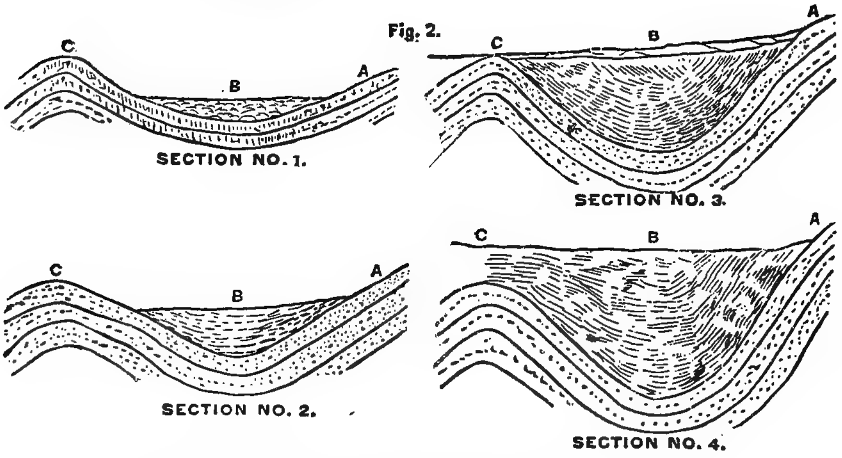


Fig. 2.



SECTION NO. 1. SECTION NO. 3. SECTION NO. 2. SECTION NO. 4.

THE OCCURRENCE OF MANGANESE AT CRIMORA, VIRGINIA.

Figure 1 is a ground plan of the immediate vicinity of the mine. The line AA is the general line of axis of the monoclinal of the potsdam sandstone, with westward dip. BB indicates the synclinal axis, which sinks rapidly to the southward. CC is the line of the anticlinal of the potsdam. Near the center of the figure is indicated a brook flowing from the monoclinal ridges of the potsdam on the east and crossing the synclinal basin and also the anticlinal fold CC to the westward. W indicates the location of the ore washer. The sections Nos. 1, 2, 3, and 4, Figure 2, are taken on lines indicated by the respective numbers in Figure 1.

It will be seen from Figure 1 that east of the mine there is a large area drained by the brook which crosses the ore basin. This drainage area is principally within the potsdam sandstone belt. The brook leaves the synclinal (ore-bearing) basin at the point where the potsdam anticlinal fold, indicated in the sections by C, sinks below the surface. It will be seen from the sections, Figure 2, that the axis C, as well as B, rapidly sinks to the northward.

The clay resulting from the decomposition of the shales has been preserved within this sharp synclinal. In section 1 scarcely any clay appears, while between sections 3 and 4 more than 300 feet of clay has been penetrated in boring for ore. The shaded portion of Figure 1 indicates the ore area, which extends irregularly northeast and southwest with the axis of the basin. The distance across the basin is one-fourth of a mile. The drainage area of the brook west of the basin is fully 10 square miles.

The fold C, section 3, forms a complete dam, back of which the seepage water is held until it can slowly work its way through the sandstone of C, or southward and past the end of the sinking anticlinal axis.

## MINING AND WASHING MANGANESE ORES AT CRIMORA, VIRGINIA.

Regarding the manganese ore deposit at Crimora, the most important in the United States, it is only necessary to say here that the ore is found in an elliptical basin 500 feet broad by 800 to 900 feet long. It is a wash deposit mixed with mud, sand, and clay. The ore varies in size from a pebble to lumps weighing a quarter of a ton or more. The larger masses are blasted in the mine and require no washing. The smaller pieces, to which the clay adheres quite tenaciously, are washed outside the mine and selections made for the home and foreign markets.

Previous to sinking the shafts a number of test holes were drilled in various portions of the estate, to give an idea of the extent and locality of the ore pockets, even when they strike rock, which may not be level.

The shafts were sunk through the clay to below the bottom of the ore and a distance from it, so that their stability will not be interfered with by the mining operations. The main tunnel was also driven outside of and below the ore for a similar reason.

From the main tunnel chutes run out in all directions to the ore pockets, where headings are driven out on the level in various directions. The excavation of the ore proceeds at several levels at once in the same pocket by stoping with timber, as shown, secondary chutes being provided, into which the material from the various levels is dumped, which finds its way to the main chute, and so to the cars. All of the mining is done by hand. Where the material is hard, hand drills and dynamite are used.

The water in the workings is conveyed in wooden troughs to the chutes, where it passes down with the material and partly washes it.

About 300 tons of material are mined in a day of 12 hours, which, after crushing, washing, and separating, leaves about 50 or 60 tons of ore.

The material having no regular formation, but being heavy and loose, necessitates strong timbering of the headings, and the timber is in some places subjected to such a great strain that it has to be renewed about every 30 days. The large quantity needed may be gathered from the fact that about 1,500,000 feet are used in the Crimora mine in a year.

The main tunnel is 7 feet square, inside measurement, having timbers 12 by 12 inches 3 feet apart, which are framed to fit into each other, as shown, to make a firm framework, and have planking or slabs 12 by 2 inches at top and sides to resist the outside pressure.

All material as it comes from the mine is dumped into the chute above the crusher and fed through it. It falls directly into the "log" washer, which consists simply of two shafts about 18 inches diameter and 24 feet long, on which are bolted spiral-shaped teeth, running in a box or frame 24 feet long, 5.5 feet wide, and 3 feet deep, filled with water. From this the material in a semiwashed state passes into the Bradford washer, which is a cylinder 13 feet long and 4.5 feet diameter, with teeth on the inner circumference about 7 inches long. From this it goes into the classifying screen (conical shape) with a mesh of 0.375 inch. All that passes over the screen runs out on the conveyor, and while it is being conveyed into the cars the flint and other refuse matter is picked out. What passes through the 0.375-inch mesh in classifying screen runs by a chute into an elevator, and is then dropped into a jig where all foreign matter is removed, the refuse passing off at the top, and the cleaned ore at the bottom runs into settling tanks and is raised by another elevator and dropped by chute into cars. All machinery works automatically, and the material is not handled after it is put into the crusher.

## THE USES OF MANGANESE.

IN POTTERY MANUFACTURE.—As has already been pointed out, the earliest known use of manganese was as coloring matter in the making of pottery and glass. So far as has been ascertained, the first manganese mined in the United States (in Tennessee in 1837) was for use in coloring earthenware. The violets, browns, and blacks of pottery are usually produced with oxide of manganese. The depth of color will depend upon the quantity used and the degree of heat applied. Excess of manganese will color jet black. Basalt or black Egyptian bodies use as high sometimes as one-sixth of the weight of the mass of manganese. Door knobs are colored black by an excess of manganese. Various shades of brown result from using varying proportions, while a slight amount will give a violet or purplish tinge to the ware. The manganese is used either in the body of the ware itself or in the glaze or the decorations. A raw black glaze may require as much as 10 to 15 per cent of manganese.

IN GLASS MAKING.—Manganese, always as pyrolusite in its purest state, is used in glass making for two purposes: first, to color violets, purples, browns, and blacks, and, second, as a decolorizer to remove the greenish tinge due to the presence of iron in the glass sand.

The use of manganese in coloring glass is similar to its use in pottery manufacture. It is employed chiefly to produce violets, pinks, or purples. The coloring properties of this as well as other metallic oxides is greatly modified by the degree of heat to which it is subjected. Not only will different temperatures give different shades of the same color, but even different colors. If the glass which has been colored pink or purple by manganese remains too long in the furnace, it becomes pale or reddish brown, then yellow, and finally green.

As a decolorizer pyrolusite has long been used, and hence its name, "savon de verriers" (glass makers' soap). The amount used will depend upon the amount of iron in the sand, but it is at the largest but a very small percentage of the batch, a half of 1 per cent. The total amount of manganese used in glass making in the United States in 1885 was but 293,850 pounds.

Just how it acts as a decolorizer is a matter of some doubt. It was long believed that its only effect was to change by oxidation the protoxide of iron, which gives glass a decidedly green tinge, to the faint yellow sesquioxide; but Liebig suggests that the effect is not simply chemical but optical, the amethyst color communicated by the manganese counteracting the yellow or greenish-yellow tint of the sesquioxide of iron, into which the protoxide is converted. Mr. Thomas Gaffield suggests that possibly both effects are produced, the manganese giving up a portion of its oxygen and its coloring power to the iron, which is converted into peroxide, giving a yellowish color to the glass, which color is complementary to whatever of purple coloring power is left in the manganese.

As the ores of manganese are usually so intimately associated with iron, great care must be exercised in procuring manganese as free from this element as possible or the substance to be removed will be increased. Great care is also necessary as to the heat of the furnace when using manganese. If the heat is too low, the oxide is not reduced and the glass has a pinkish tinge or "high color", as it is termed, while if the furnace is too hot it is completely reduced, and a greenish or "low color" is the result.

Some deposits of pyrolusite suitable for glass making are found in this country, but most of the deposits worked for manganese contain impurities that unfit it for glass. The manganese from the Crimora mine, Virginia, one of the chief sources of supply of this ore for the manufacture of ferro-manganese, is too high in iron and cobalt for glass. At Mount Athos, in the same state, a deposit is found that meets the requirements of glass making. This ore contains from 90 to 95 per cent of binoxide of manganese, 0.02 per cent of iron, and no copper or cobalt.

A manganese much used in the glasshouses of the United States is a very pure pyrolusite from Nova Scotia. Analyses of this ore from the Crystal mine show from 90.50 to 98.05 per cent of binoxide of manganese and practically no iron. The ore is crystalline, soft, and easily reduced to powder. Saxony and Turkey are also sources of supply of this material.

IN THE MANUFACTURE OF CHLORINE.—A very large amount of manganese is used in Europe in the manufacture of the chlorine gas used in the production of bleaching powder or chlorate of lime. The production of manganese ore in the United States prior to 1875 was chiefly for use in chemical works, most of it being exported to England. The explorations of Sibert in Virginia in 1859 and of Mills in the same state in 1867–1871 were for manganese for English chemical works.

As has been stated, chlorine was discovered by Scheele while investigating manganese, and was described by him in 1774. In 1785 its value as a bleaching agent was pointed out, and now most of the chlorine used in making the various commercial bleaches is made from manganese.

The ore used is the peroxide. It must be free from impurities that are soluble in hydrochloric acid, especially iron alkalies and alkaline earth. The softer the ore the better. Some ores that are otherwise up to the standard are too hard for chlorine manufacture. The ore must also be rich, 60 to 65 per cent at least binoxide, while in some cases 70 per cent binoxide or 44.25 per cent of metallic manganese is the lowest that will be accepted.

The method of producing chlorine is simple. Coarsely ground ore is treated in an oblong stone still with hydrochloric acid, at first without the aid of heat, but after 8 or 10 hours steam is forced into the mixture. The process requires 24 hours.

The products are chloride of manganese, water, and chlorine. The chlorine is conducted away in pipes leading from the top of the still. The "still liquor", which contains the chloride of manganese and water, as well as other chlorides with free acid and chlorine, and which was allowed to go to waste until 1855, is now treated, and the manganese recovered as peroxide with but little loss of manganese.

IN THE MANUFACTURE OF BROMINE.—The use of manganese in the manufacture of bromine is analogous to its use in chlorine production. It is made from the "mother liquor" or "still liquor" of salt water after the extraction of the salt. This liquor contains the salt that is not evaporated and the soluble bromine. Sulphuric acid and pyrolusite are added to the liquor, and as a result the bromine is set free. But a small amount of manganese is used in this country for this purpose.

IN THE MANUFACTURE OF STEEL.—It is in the manufacture of steel that manganese finds its greatest demand. In the crucible process it is charged into the pots either in the form of ore at the time of charging, or it is added as spiegeleisen or ferro-manganese at the time of charging or during the melting, usually toward the close, so as to prevent a too great loss of manganese by oxidation.

In the bessemer and open-hearth processes the manganese is added as spiegel or ferro at or near the close of the process.

The effects produced by the manganese in the manufacture of iron and steel are too intricate and at the same time too much in question to be discussed here. It may be said in a very general way that the manganese prevents ebullition during the solidification of the steel and the formation of blowholes, and also prevents red shortness. It is also used as a recarbonizer in the manufacture of bessemer steel, by depriving it of its oxygen, to reduce the small quantities of oxides of iron formed in the steel during its final melting.

OTHER USES.—Manganese is also used as a paint, as a coloring matter and mordant in dyeing and calico printing, in the manufacture of oxygen, as a material in the manufacture of disinfectants, in electrical batteries, and alloyed with copper, iron, bronze, and other metals for various uses, especially for general bearings.

## THE MANUFACTURE OF SPIEGELEISEN AND FERRO-MANGANESE.

Spiegeleisen and ferro-manganese are alloys of manganese, carbon, and iron in varying proportions, spiegeleisen containing the smaller amount of manganese and ferro the higher. Just where the dividing line between spiegeleisen and ferro-manganese should be placed is not determined. In some cases the dividing line is placed at 30 per cent of manganese, in some cases at 20 per cent of manganese, and in others as high as 40 and even 45 per cent. Assuming 30 per cent of manganese as the dividing line, pig iron containing this amount and less would be classed as spiegeleisen; that containing from 30 per cent to, say, 60 per cent of manganese as "low ferro", and from 60 per cent of manganese to as much as 92 per cent "high ferro". The carbon in these compounds varies from 4 to 7 per cent, being as a rule most when the manganese is highest.

Spiegeleisen was first produced in blast furnaces as an accidental product where the burden of the furnace contained more than the usual amount of manganiferous iron ores. As has been pointed out, manganese and manganiferous iron ores often displace in the same mine the true iron ores. When this would happen, and the manganese or manganiferous iron ore would be charged into the small furnaces in use 30 to 50 years ago, the product would be a pig iron with large grains of a whitish color, with brilliant faces sometimes fully an inch square. The Germans gave to this accidental product the name spiegeleisen, or "looking-glass iron", from these large, brilliant facets of crystallization. At many of the old charcoal furnaces in the Shenandoah valley broken pieces of spiegeleisen, so made fully half a century ago, may still be found where they were thrown in the "dump", no use for it being known at that time.

It was the recollection of seeing such irons in Germany and the belief that this crystallization was due to carbon that led Mushet to suggest the use of spiegeleisen as a material for recarburizing in the Bessemer converter. Percy, however, pointed out that this curious form of crystallization was due not to carbon, but to the presence of manganese, showing that when manganese was absent he was unable to find the "specular cast iron" with this characteristic crystallization.

Mushet seems to have been the first who had made ferro-manganese, he having succeeded about 1830 in making a low ferro, containing about 30 per cent of manganese. On page 773 of his Papers on Iron and Steel, published in 1840, an analysis of an alloy containing 28.6 per cent of metallic manganese is given.

Mushet does not seem to have made any practical use of his discovery, and it was left for Mr. Henderson, the noted chemist of the Saint Rollox works near Glasgow, to produce ferro on a commercial scale in a reverberatory furnace.

The first use of ferro-manganese in any great quantities was in connection with the Bessemer process for recarburizing. Bessemer first announced his invention in 1856. Shortly after this announcement Robert Mushet took out patents in England for improvement on this process by the introduction of a "triple compound" of iron, manganese, and carbon, which improvement was perfected by subsequent patents by the same inventor.

The spiegeleisen which was at first used contained but from 7 to 8 per cent of manganese with 4 per cent of carbon and 88 per cent of iron. As the use of the Bessemer process increased Mr. Bessemer began to see the necessity of manufacturing ferro-manganese on a large scale for his process, for the reason that it would enable him to make a very mild metal, while the use of spiegeleisen would not permit of such a product, owing to the large quantity of carbon in the pig. Hearing that Mr. Henderson was manufacturing ferro-manganese at Glasgow, he explained to him what was required, when Mr. Henderson at once saw his way clear to the production of the material on a commercial scale, producing shortly a ferro with 50 per cent and gradually increasing it to at least 75 per cent.

It should be said that in the meantime experiments had been made at Terre Noire by Mr. Valton in 1866. The Terre Noire steel works purchased from Mr. Henderson his patent, perfected the process, raised the percentage of manganese from 25 to as high as 75 per cent, and reduced the price 50 per cent, though in 1871 an alloy containing 40 per cent of manganese produced at Terre Noire sold at $600 a ton.

At first ferro-manganese in commercial quantities was produced by Mr. Henderson in a reverberatory or open-hearth furnace, his product containing in 1865 only from 25 to 30 per cent of metallic manganese. About the same time, however, a ferro containing 75 per cent of metallic manganese was being made at Cologne by M. Oscar Prieger in a crucible furnace. These methods were used to produce alloys containing the higher percentages of manganese, because it was found at that time that the blast furnace did not give the heat necessary, though the blast furnace could be used for the production of spiegeleisen, in which the amount of manganese contained was small and the consequent heat required low. At the present time, however, all ferro is manufactured in the blast furnace, the greatly increased heats, due to the introduction of the Siemens, Cowper, Whitwell, and other hot-blast stoves, rendering it practicable to obtain in the blast furnace the high temperatures needed for the manufacture of the high ferros. It is necessary, therefore, to discuss only the manufacture of spiegeleisen and ferro in the blast furnace.

Given an ore of proper chemical character, the chief difficulty in the production of spiegeleisen and ferro in the blast furnace is the regulation of the heat.

While a high heat is necessary, say 1,200° fahrenheit, if the blast is heated to a much higher temperature, say 1,400° to 1,500° fahrenheit, there is danger that the silicon may be too high and the product of an inferior quality. Owing to these high temperatures the lining of the furnace is much more quickly worn out than in the case of smelting the ordinary ores.

A considerable portion of the manganese, say from one-fifth to one-third, is wasted in smelting, a portion of it going off into the slag, and another portion in the fumes given off by the furnace. This volatilization of manganese in the furnace operations is a notable characteristic of the production of ferro.

Coke is the best fuel, the consumption varying from 4,800 pounds to 5,000 pounds per ton, the higher grades requiring the most coke. The production of the modern blast furnace is from 34 to 36 tons of ferro-manganese of 78 to 84 per cent per 24 hours, or 230 to 250 tons per week.

For the best working of the furnace in making ferro-manganese a highly basic slag with good fuel and comparatively slow working are necessary. With a basic slag there is a considerable saving in the amount of manganese that enters into the slag, and even with all precautions sometimes over 15 per cent of manganese is lost.

Analyses of the slag show from 28 to 30 per cent of silica, the same amount of lime, and from 20 to 40 per cent of protoxide of manganese.

In this country considerable spiegeleisen is made from the residuum of the franklinite ores of New Jersey after they have been worked for the zinc. This residuum is worked by the New Jersey Ore and Zinc Company, at Newark, New Jersey; the Passaic Zinc Company in Hudson county, New Jersey, and the Lehigh Iron and Zinc Company, at Bethlehem, Pennsylvania.

The following statement, specially prepared for this report by Mr. George L. Stone, of the New Jersey Zinc and Iron Company, treats of these ores and their use in the manufacture of spiegeleisen:

The principal deposit is at Franklin, where there are 2 mines. The Taylor, on the south end of Mine Hill, is owned and worked by the New Jersey Zinc and Iron Company; the smaller mine, on the north end of the hill, is worked by the Lehigh Zinc and Iron Company, and is on the smaller and leaner branch of the vein. The second deposit is at Sterling Hill, about 2 miles from Franklin. There are 2 mines, side by side, on the same vein, owned by the New Jersey Zinc and Iron Company and the Passaic Zinc Company. At present the New Jersey Zinc and Iron Company are not working their Sterling Hill mine.

The principal minerals of the ore are franklinite and willemite, with varying quantities of zincite and calcite. Occasionally the ore contains noticeable amounts of rhodonite and tephroite. The other minerals of the ore are not present in sufficient quantity to be of economic importance. The greater part of the manganese in the ore is in the franklinite, which contains from 9 to 20 per cent; the willemite contains from 2 to 7 per cent. The two silicates of manganese, rhodonite with 42 and tephroite with 54 per cent, are seldom present in sufficient quantity to add appreciably to the value of the ore.

The ore from the Taylor mine contains $SiO_2$ 9 to 12, $Fe_2O_3$ 27 to 33, MnO 13 to 18, ZnO 25 to 40, and calcite 4 to 16 per cent. The ore from the north end of the hill is leaner, containing more calcite and rock, and frequently more phosphorus. The Sterling Hill ore contains $SiO_2$ 4 to 5, $Fe_2O_3$ 25 to 30, MnO 12 to 14, ZnO 20 to 30, and calcite 20 to 30 per cent. The following are analyses of large lots:

ANALYSES OF STERLING HILL ORE.

| COMPONENT PARTS. | No. 1. | No. 2. | No. 3. | No. 4. | No. 5. | No. 6. |
|---|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| $SiO_2$ | 10.21 | 11.08 | 10.33 | 4.86 | 5.15 | 11.77 |
| $Fe_2O_3$ | 31.41 | 27.54 | 30.36 | 30.33 | 27.62 | 30.91 |
| MnO | 15.84 | 17.63 | 15.95 | 12.30 | 13.09 | 10.27 |
| ZnO | 32.83 | 35.88 | 26.34 | 29.42 | 23.38 | 25.71 |
| $Al_2O_3$ | 0.21 | 0.24 | 1.16 | 0.67 | 0.64 | 2.01 |
| CaO | 5.09 | 2.01 | 7.15 | 12.65 | 14.37 | 10.43 |
| MgO | .......... | 0.77 | 1.09 | .......... | 1.98 | 0.99 |

Nos. 1 and 2 were selected ore from the Taylor mine; No. 3, lean ore from Taylor mine; Nos. 4 and 5, Sterling Hill ore; No. 6, ore from north end of Mine Hill, leaner than the average.

The ore is all used just as mined, without concentration. At one time the Lehigh company concentrated some very lean calcareous ore by calcining it in an ordinary limekiln and washing out the lime in a log washer similar to those used for iron ores. The results were fairly satisfactory, but they have not continued the practice. An attempt was made at the old Stanhope furnace in 1852 to work these ores raw in the blast furnace, but the zinc blocked the gas flues, which burst, causing a fire which destroyed a large part of the plant. The manager of the furnaces, Mr. Edwin Post, expressed his belief that with properly arranged gas flues there would be no difficulty in working the ore; but the experiment was not repeated there. The old New Jersey Zinc Company made several attempts to work the ore raw in the blast furnace, but none of them were successful. Of late years all the ore has been first treated by the Wetherill process for making zinc oxide, and the resulting clinker, or residuum, alone used in the blast furnace. The clinker is in pieces varying from flat cakes a foot in diameter and about 2 inches thick to fine dust. Formerly it was all screened through screens with a 1-inch square mesh, and only the coarse used for the blast furnace, but at present it is all used, coarse and fine together. The anthracite culm used as fuel in the oxide furnaces contains from 15 to 25 per cent of ash. This and the limestone added nearly make up for the zinc that is volatilized, so that a ton of ore makes just about a ton of clinker. The clinker varies a good deal in composition between the following limits: $SiO_2$ 18 to 25, $Fe_2O_3$ 29 to 36, $Al_2O_3$ 2 to 9, MnO 10 to 20, ZnO 3 to 15, CaO 8 to 16, and MgO 1 to 4 per cent. It is impossible to give an average analysis. The Passaic company makes the least siliceous clinker and the Lehigh the most. Speaking generally, the Passaic clinker is the richest, the New Jersey the next, and the Lehigh the leanest, though at times the order may be reversed.

The New Jersey Zinc Company was the first to make spiegel. Their first furnaces were very small, usually 7 feet bosh by 19 feet to the stock line, with open fronts and open tops. They had tried closed fronts and tops, but did not succeed with them. The Lehigh company's furnace, built in 1881, was the first successful closed front furnace. It was 27 feet to the stock line, with a 4-foot hearth and 8-foot bosh. The top was closed by a hinged cover. This furnace worked very satisfactorily, but the clinker they had at that time was so lean that the make of iron was very small and the cost high. The first of the new furnaces of the New Jersey Zinc and Iron Company was blown in in 1883 and a second in 1885. They have been changed very little since. The Passaic Zinc Company's furnace was also built in 1883. It is about the same height as the others, but wider in the bosh, giving a good deal more capacity. At first the top was closed by a swinging lid, but this not proving satisfactory it was replaced by a bell and hopper.

All the furnaces use Cooper-Durham ovens and return-flue boilers. The Lehigh and New Jersey companies have Dickson blowing engines with 28-inch steam cylinders, and 36-inch stroke. They have not sufficient inlet-valve area, and consequently do not deliver nearly their piston displacement of air. The Passaic company has a Weimer engine, which is more effective.

In making low-grade spiegel the furnaces cut much more in the hearth than when making high grade, as at present, when they are apt to fill up with graphite, which can usually be cleaned out by charging low-grade spiegel scrap to the amount of 10 to 15 per cent of the iron made. The cinder is usually nearly a unisilicate, with about 35 per cent of silica. When the alumina is unusually high, decreasing the lime will usually improve the cinder. The following analyses are of the cinder usually made.

ANALYSES OF CINDER.

| COMPONENT PARTS. | No. 1. | No. 2. | No. 3. | No. 4. | No. 5. |
|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| $SiO_2$ | 35.77 | 32.60 | 37.12 | 32.59 | 30.51 |
| $Al_2O_3$ | 11.67 | 13.06 | 11.72 | 10.61 | 12.12 |
| ZnO | | | | 0.71 | 0.82 |
| FeO | 2.09 | 2.85 | 2.27 | 1.85 | 5.26 |
| MnO | 9.51 | 13.07 | 12.42 | 8.35 | 6.44 |
| CaO | 30.36 | 30.58 | 27.24 | 32.80 | 32.02 |
| MgO | 10.39 | 7.54 | 8.84 | 11.47 | 13.31 |
| Total | 99,79 | 99.70 | 99.61 | 98.38 | 100.48 |

Nos. 1, 2, and 3 are from the New Jersey furnaces. No. 1 is normal cinder. No. 2 is unusually basic and No. 3 unusually acid, both containing too much manganese. No. 4 is cinder made at the Passaic furnace in 1889. No. 5 was made at the same furnace in 1890, and is rather remarkable for the high iron together with low manganese.

The worst difficulty in working the clinker comes from the oxide of zinc it contains. This is usually about 5 to 6 per cent, but occasionally as much as 15, which not only requires a good deal of coal in the furnace, but necessitates an elaborate system of dust catchers or condensers and frequent stops to clean them and the gas flues. The New Jersey company has but 1 set of condensers at each furnace and has to stop at least once a week an hour and a half or two hours to clean out. The Lehigh and Passaic companies have each 2 sets, so that 1 can be cleaned while the other is in use. The condensers used by all the companies are similar. Each consists of a square cast-iron box at top and bottom connected by sheet-iron pipes. The New Jersey and Lehigh companies have 5 pipes and the Passaic 9 in each condenser. Increasing the length of the pipes does not appreciably increase the effectiveness of the condensers. The New Jersey company has 1 large condenser 33 feet high, 4 feet by 6 in cross-section, with inclined shelves, which is much more effective than the pipe condensers. The best means of catching the oxide seems to be sharp turns in the flues and long horizontal flues. At first the Passaic company used wet scrubbers. They were very effective, but were abandoned, partly because they were thought to be the cause of some bad explosions and partly from the difficulty of collecting the oxide carried off by the waste water.

The richness of the oxide in zinc varies in different parts of the flues and condensers. At the Passaic furnace the oxide from the flues at the tunnel head contains about 56 per cent of zinc. The downcomers give the richest oxide, 76 per cent. In the first condenser it contains but 18 per cent; in the remaining condensers it varies from 54 to 60, the richest coming from the third, the poorest from the last. It grows richer again farther from the furnace, containing 66 per cent at the end of the flue. At the New Jersey furnaces the oxide from the flues at the top and from the condensers contains from 63 to 70, the richest being at the burners of the ovens (where there is often a good deal of metallic zinc), averaging 85 per cent. The oxide collected in the ovens and under the boilers is much lighter, and contains but 40 to 50 per cent of zinc. The following are average analyses of the oxide:

ANALYSES OF THE ZINC OXIDE.

| COMPONENT PARTS. | No. 1. | No. 2. | No. 3. |
|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* |
| $SiO_2$ | 3.06 | 4.46 | 9.70 |
| $Fe_2O_3$ and $Al_2O_3$ | 2.18 | 3.50 | 5.35 |
| MnO | 4.03 | 4.66 | 5.45 |
| ZnO | 84.50 | 79.54 | 50.28 |
| CaO | 1.18 | 1.50 | 7.98 |
| MgO | 1.07 | 1.39 | 5.31 |

Nos. 1 and 2 are from the New Jersey Zinc and Iron Company and No. 3 is from the Passaic Zinc Company.

A large proportion of the oxide is carried off by the escaping gases and lost. The zinc oxide forms a hard ring around the throat of the furnace, which has to be cut off occasionally, a work that is not only very hard on the men, but is apt to cause the furnace to work badly, owing to the large amount of zinc that drops into it. To prevent trouble it is well to charge one or two blanks long enough beforehand to have the extra coal near the tuyères when starting, to charge a large coal blank the last thing before the stop, and to fill on top of the oxide with light charges, such as would be used in blowing in, increasing the burden quite rapidly, so as to get back to the normal in about 36 hours. This will usually prevent any bad effects, even when 2 or 3 tons of oxide are cut off and dropped into the furnace at once. When the furnace works regularly the zinc gives but little trouble beyond requiring a good deal of fuel and necessitating cleaning the flues; but if on account of any accident the furnace is stopped for any length of time, it will chill all through the charge, forming a pasty mass that it is impossible to melt and difficult even to shovel out. Pieces of zinc will often float and burn on the cinder and iron, but it seldom if ever combines with either.

Furnace B of the New Jersey company, as at present lined, is 34 feet 9.5 inches high, 8-foot bosh, 5-foot hearth, and 6 feet at the stock line, with a bell 3 feet 4 inches in diameter. It has cooling plates at the tuyères, taphole, and cinder notch, and sheet-iron jackets, with spray pipes above and below the tuyères. It is seldom necessary to use much water on the bosh. The lining is very light, being but 14 inches thick. The blast is about 4,000 feet a minute (engine measurement), at a pressure of from 3 to 5 pounds, heated to 950°. The furnace above the stock line is inclosed by cast-iron doors hinged to posts. Around the edge of the hopper are holes (with loose covers) through which bars can be passed to cut the accretions of zinc oxide from the walls without danger of cutting into the lining. The gas outlet is 2 feet 6 inches. During 1889 this furnace made 3,478 tons 5 hundredweight 90 pounds of iron, 83 per cent of which contained over 20 per cent of manganese, the average for the year being 21.09 per cent. The clinker yielded 30.15 per cent of spiegel. It required 2 tons 13 hundredweight 67 pounds of coal to make 1 ton of spiegel. The best day's work was 13 tons 8 hundredweight 100 pounds, and the best week's work 85 tons 18 hundredweight 84 pounds, from clinker yielding 35 per cent. The oxide (flue dust) collected averaged 267 pounds per ton of iron. In 1890 the make was 3,197 tons 3 hundredweight 104 pounds, 79 per cent of which was higher than 20 per cent spiegel, the average manganese for the year being 20.93 per cent. The best day's work was 10 tons 16 hundredweight 68 pounds, and the best week's work was 69 tons 19 hundredweight 12 pounds; the average yield of the clinker was 30.53 per cent, and the coal required per ton of iron was 2 tons 12 hundredweight 66 pounds. 266 pounds of flue dust were collected for each ton of iron made. The average length of blast at this furnace has been about 3 years.

Furnace A of the New Jersey company is very similar to B in general form and construction. The hearth and stock line are each 6 inches wider than B. The lining is thicker, 16 inches on the bosh and 24 inches above the bosh. This extra lining has been a decided improvement, the blasts lasting longer, the furnace working better and being less affected by stops. The cooling arrangements are the same as at B. The principal difference is in the top, the doors at A being inclined and hinged. This construction keeps the entire hopper out of the furnace, which makes it very durable. The original hopper is still in use, and is apparently as good as ever after 6 years' wear. This entire arrangement of the top castings has proved to be the most satisfactory of any that this company has tried. The doors around the top are not only useful for cleaning, but have more than once been the means of saving the furnace when it had formed a "zinc scaffold" just under the bell. Opening the doors gave a chance to get at the trouble, break up the scaffold, and even to take a good deal of it out of the furnace, which could not have been done through the opening between the bell and hopper.

In 1889 A made 3,393 tons 5 hundredweight 80 pounds of iron, averaging 20.62 per cent of manganese. It required 2 tons 12 hundredweight 45 pounds of coal to make 1 ton of iron with clinker yielding 31.12 per cent. The best day's work was 13 tons 2 hundredweight 96 pounds of iron, and the best week's work 85 tons 10 hundredweight 100 pounds. The charge was 92 per cent clinker and 8 per cent of a 50 per cent iron ore, the yield of the whole being 35 per cent. The oxide collected amounted to 260 pounds per ton of iron. In 1890 the make was 3,440 tons 17 hundredweight 46 pounds, containing 20.77 per cent of manganese. The best day's work was 11 tons 15 hundredweight 20 pounds, and the best week's work 78 tons 3 hundredweight 64 pounds. The clinker yielded 32.22 per cent, requiring 2 tons 10 hundredweight 22 pounds of coal for 1 ton of iron. The oxide collected was 251 pounds per ton of iron. The quantity, temperature, and pressure of blast were about the same as at furnace B. The stops for cleaning out are the same at both furnaces, two a week, one of about 15 minutes to clean the flue at the throat, where it is most rapidly choked with oxide, and one of from 1.5 to 2 hours to clean all the flues and condensers. The boiler flues are brushed out twice a day without stopping, but merely shutting off the gas from the pair being cleaned. The oven pipes are cleaned daily by an air blast and scrapers, the 2 ovens keeping 1 man busy cleaning. Each furnace has 5 tuyères, 4 of 3 inches in diameter and 1 of 2.25 inches. Iron coil tuyères are used. The 2 furnaces are so much alike that there is naturally very little difference in their working. A works a little more regularly and economically; B usually makes slightly better iron. Both furnaces were continuously in blast during the 2 years.

The Passaic Zinc Company's furnace is of a radically different shape, the hearth and bosh being much wider in proportion to the height, while the angle of bosh is about the same, making the top of the bosh very near the top of the furnace. The object of this was undoubtedly to get greater capacity in the furnace without increasing the height, which it was feared would cause more trouble from the zinc. The furnace has done excellent work, frequently making 14 tons a day of 21 per cent iron for considerable periods. The years 1889 and 1890, which have been taken for comparison, do not give a fair showing for this furnace, as it was blown out in July, 1889, and blown in again in September of the same year. In 1890 the furnace was stopped for nearly a month, in February and March, owing to a chilled hearth, but since then it has been doing well. In 1889 the furnace was in blast 312 days, and made 3,974 tons of spiegel averaging 21 per cent in manganese. It required 2 tons 12 hundredweight 22 pounds of coal to make 1 ton of spiegel from clinker yielding 31.36 per cent. 31.3 per cent of limestone was used. 324 pounds of oxide were collected for each ton of iron made. In 1890 the furnace did better, in 341 days making 4,210 tons of spiegel, the clinker yielding 32.26 per cent. But 2 tons 9 hundredweight 22 pounds of coal were used to the ton of iron. The limestone was 27 per cent of the clinker; the oxide collected, 220 pounds per ton of spiegel.

The furnace is water-jacketed up to the mantel. The peculiar top is due to the furnace having been built at first to run open top. The bell and hopper were added later, and this arrangement, having worked well, has been kept in use. The blast averages 3,140 cubic feet per minute (engine measurement), at a pressure of 5 pounds and a temperature of 850°, blown through 5 tuyères 3 inches in diameter. While this is apparently a good deal more blast than is given to the smaller furnaces of the New Jersey company, yet, owing to the greater efficiency of this engine, the difference is the other way.

The New Jersey and Passaic companies use the same coal and limestone. The following analyses show their composition:

ANALYSES OF COAL AND LIMESTONE USED.

| COAL. | PER CENT. | LIMESTONE. | PER CENT. |
|---|---|---|---|
| Moisture | 3.89 | Silica | 2.81 |
| Volatile combustible matter | 4.31 | Oxide of iron | 1.58 |
| Fixed carbon | 79.91 | Lime | 29.49 |
| Ash | 11.89 | Magnesia | 20.28 |
| | | Carbonic acid | 45.47 |

The clinker varied a good deal in composition, but the following analyses are given as fairly representative:

ANALYSES OF CLINKER.

| COMPONENT PARTS. | 1889. | 1890. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Silica | 20.14 | 18.43 |
| Alumina | 4.44 | 8.65 |
| Oxide of iron | 31.37 | 30.13 |
| Oxide of manganese | 15.96 | 13.18 |
| Oxide of zinc | 3.76 | 4.43 |
| Lime | 15.61 | 14.67 |
| Magnesia | 2.59 | 3.20 |

The furnace of the Lehigh Zinc and Iron Company as at present lined is much like the New Jersey furnaces in shape. It is wider and about the same height. The hearth below the tuyères is surrounded by coil plates. From the tuyères to the mantel the lining is but 9 inches thick, and is cooled by vertical pipe coils. The top is watercooled by coil plates extending 3 feet 6 inches below the hopper. Instead of the doors around the top used in the other furnaces, the entire bell and hopper of this are hoisted out and run to one side, suspended from a trolley on an overhead track. This arrangement is said to be very satisfactory. The clinker is very siliceous. The following are the average analyses:

| COMPONENT PARTS. | No. 1. | No. 2. |
|---|---|---|
| | *Per cent.* | *Per cent.* |
| Silica | 27.66 | 25.13 |
| Oxide of manganese | 13.46 | 13.47 |
| Oxide of iron | 35.77 | 33.24 |
| Oxide of zinc | 5.93 | 5.63 |

The Lehigh company finds it advantageous to use part iron ore, and make low-grade spiegel. The ore used is "blue billy" (burnt pyrites) from acid works. It contains silica 7.90, oxide of iron 78.00, phosphorus 0.009, and sulphur about 2 per cent. The coal is of about the same quality as that used at the other furnaces. The limestone is a very clayey dolomite, containing silica 6.46 per cent; alumina, 7.52 per cent; lime, 28.58 per cent; magnesia, 15.66 per cent, and phosphorus, 0.019 per cent.

Two stops a week of about half an hour each are made to clean flues. The average length of blast is about 18 months. The oxide averages 49.5 per cent of zinc.

The blast is 3,540 cubic feet per minute (engine measurement), at a pressure of from 4 to 5 pounds, heated to 900°, blown through 6 3-inch tuyères. In 1889 the furnace made 3,238 tons of spiegel averaging 12.20 per cent of manganese. The fuel, one-eighth coke, was 3 tons 3 hundredweight per ton of iron; the charge averaged 81 per cent clinker and 19 per cent ore, with 62 per cent limestone. The yield was 33.73 per cent. 264 pounds of oxide were collected for each ton of iron made.

In 1890 less ore was used and the clinker was much richer. 3,670 tons of spiegel were made, 883 tons of which contained 20 per cent of manganese, the remainder containing 12.50. Less than 2 per cent of coke was used, the fuel averaging 2 tons 11 hundredweight 67 pounds per ton of spiegel. The ore mixture (93 per cent clinker, 7 per cent ore) yielded 37.19 per cent. But 50 per cent of limestone was used. 228 pounds of oxide per ton of iron were collected.

It is difficult to make any comparison of the work done by these furnaces with large iron furnaces, owing to the great difference in the yield and character of the ore. Rapid driving is undoubtedly advantageous, making both a cheaper and better product. It is impossible to compare the rate of driving by means of the number of cubic feet required to produce 1 ton of iron, owing to the difference in the yield, or by the weight of fuel burned per square foot of hearth, owing to the difference in the proportion of hearth area to volume, but comparison can be made as to the length of time the stock is in the furnace, or, what amounts to the same thing, the number of tons of stock worked per day for each 100 cubic feet in the furnace. At these furnaces it varies from 4.44 tons at the Lehigh to 5.72 tons at the Passaic, while at the large Edgar Thompson furnaces it is about 5.

The following table gives a comparison of the work of the 4 furnaces for the years 1889 and 1890:

COMPARATIVE STATEMENT OF FURNACE WORK.

| ITEMS. | New Jersey A furnace. | New Jersey B furnace. | Passaic. | Lehigh. |
|---|---|---|---|---|
| Cubic feet in furnace to stock line | 1,243 | 1,134 | 1,443 | 1,545 |
| Iron made per day (in tons, hundredweights, and pounds) | 9 7 27 | 9 2 101 | 12 7 67 | 9 9 29 |
| Cubic feet per ton of iron per day | 133 | 124 | 116 | 163 |
| Yield of clinker (per cent) | 31.36 | 30.34 | 31.86 | 35.48 |
| Fuel per ton of iron (tons) | 2.57 | 2.66 | 2.53 | 2.84 |
| Per cent of limestone | 23.60 | 23.80 | 29.10 | 56.00 |
| Stock per day per 100 cubic feet (tons) | 4.95 | 5.44 | 5.72 | 4.44 |
| Approximate weight of cinder per ton of iron (tons) | 2.34 | 2.44 | 2.34 | 2.47 |

The analyses of the spiegeleisen made by the New Jersey Zinc Company from these ores is as follows:

ANALYSES OF SPIEGELEISEN MADE BY THE NEW JERSEY ZINC COMPANY.

| COMPONENT PARTS. | No. 1. | No. 2. |
|---|---|---|
| Manganese | 11.586 | 11.67 |
| Iron | 83.250 | 83.23 |
| Silicon | 0.367 | 0.99 |
| Phosphorus | 0.196 | 0.19 |
| Carbon | 4.632 | 4.02 |
| Total | 100.031 | 100.10 |

The production of spiegeleisen and ferro-manganese in the United States from 1872 to 1890, inclusive, is as given below:

PRODUCTION OF SPIEGELEISEN AND FERRO-MANGANESE IN THE UNITED STATES FROM 1872 TO 1890, INCLUSIVE, IN TONS OF 2,000 POUNDS.

| | | | |
|---|---|---|---|
| 1872 | 4,072 | 1882 | 21,963 |
| 1873 | 3,930 | 1883 | 24,574 |
| 1874 | 4,070 | 1884 | 33,893 |
| 1875 | 7,832 | 1885 | 34,671 |
| 1876 | 6,616 | 1886 | 47,982 |
| 1877 | 8,845 | 1887 | 47,598 |
| 1878 | 10,674 | 1888 | 54,769 |
| 1879 | 13,931 | 1889 | 85,823 |
| 1880 | 19,603 | 1890 | 141,162 |
| 1881 | 21,086 | | |

The production of 1872, 1873, and 1874 was entirely from zinc residuum ores. The production at the present time is from zinc residuum ores from native and imported manganese and manganiferous iron ores.

The imports of spiegeleisen and ferro-manganese have been as follows:

IMPORTS OF MANGANESE AND SPIEGELEISEN FOR 1876, AND FROM 1883 TO 1890, INCLUSIVE.

| YEARS ENDED— | Spiegeleisen. (Long tons.) | Value. |
|---|---|---|
| June 30, 1876 | 3,391 | $6,967 |
| 1883 (*a*) | 67,881 | 1,991,945 |
| 1884 | 94,210 | 2,353,368 |
| 1885 | 65,406 | 1,587,103 |
| 1886 | 99,426 | 2,188,363 |
| 1887 | 150,205 | 3,327,128 |
| 1888 | 103,973 | 2,368,600 |
| 1889 | 93,032 | 1,757,035 |
| 1890 | 108,771 | 3,032,006 |

*a* Not separately classified from 1877 to 1882, inclusive.

# CHROMIC IRON ORE.

# CHROMIC IRON ORE.

The production of this substance is carried on in an exceptionally irregular way because the 2 companies that make the bicromates of sodium and potassium from it are independent of the domestic product and can obtain as much as they need from Turkey and Asia Minor. At present the ore is produced only in California. It occurs there in many counties very irregularly, in disconnected masses imbedded in the country rock, serpentine, and in uncertain quantities. The quality of the ore is lower than that of Turkey.

STATISTICS OF CHROMIC IRON ORE PRODUCTION IN CALIFORNIA AT THE ELEVENTH CENSUS.

| | |
|---|---|
| Product (long tons) | 2,000 |
| Value delivered at San Francisco | $30,000 |
| Number of employés | 30 |
| Number of mines | 6 |
| Total expenditures for wages | $6,000 |
| Other expenditures | $4,000 |
| Total capital invested | $8,000 |

The value given above is that in San Francisco. This is given because an average value at the mines would be absolutely without meaning, since a great and variable item of expense is the wagon hauling before rail shipment, as shown by the following analyses of the cost of the ore carried to New York or Philadelphia, where it is consumed:

COST PER TON OF CALIFORNIA CHROMIC IRON ORE LAID DOWN IN NEW YORK.

| COUNTIES. | Per cent of ore. | Total. | Royalty to owners. | Mining. | Hauling. | Freight to San Francisco. | Carting to ship. | Interest and insurance. | Freight to New York. |
|---|---|---|---|---|---|---|---|---|---|
| Del Norte | 45 | $17.25 | | $3.00 | $3.00 | $4.50 | $0.75 | $1.00 | $5.00 |
| Placer | 52 | 20.95 | $0.25 | 3.00 | 8.00 | 3.00 | 0.70 | 1.00 | 5.00 |
| San Luis Obispo | 47 | 17.40 | 2.00 | 3.00 | 2.55 | 3.85 | | 1.00 | 5.00 |
| Shasta | 45 | 17.50 | 2.50 | 3.00 | 1.00 | 4.25 | 0.75 | 1.00 | 5.00 |
| Tehama | 45 | 18.25 | 2.00 | 1.50 | 3.50 | 3.00 | 2.25 | 1.00 | 5.00 |

## HISTORY.

The occurrence of chromic iron ore in the United States has been known from the early part of this century, having been discovered by Mr. Isaac Tyson on his farm at Bare Hills, Baltimore county, Maryland, about 1823 From this time to 1845 ore was shipped by Mr. Isaac Tyson, jr., to England more or less irregularly, this being the only market for it. The original discovery was soon exhausted, and, the trade with England being established, inquiry for new deposits was instituted. Valuable ore was discovered at Soldiers Delight, Baltimore county, and in Harford and Cecil counties, Maryland; also in Lancaster, Delaware, and Chester counties, Pennsylvania. Whenever a deposit was discovered Mr. Tyson investigated it, and if valuable obtained control of it. The discoveries increased so rapidly that Mr. Tyson, fearing more deposits would be found than he could control and thus the market in England become overstocked, set about to create a home demand for the ore. In 1845 he established works for utilizing chromic iron ore, which monopolized this industry in the United States, owing to secret modifications of the usual process of manufacture, until within the last few years. In addition to the localities above mentioned, sporadic occurrences of this ore have been reported in New York, Massachusetts, Vermont, Virginia, and North Carolina, but from none of these has any ore been produced. About 1873 Mr. Tyson was informed that a discovery of this ore had been made in Del Norte county, California. He sent a surveyor to investigate the reported find, but it proved to be of no value. Strange to say, however, a large deposit of chromic iron ore was found in another part of this county by the same surveyor, which has been a productive source of chromic iron ore until the present time. Since this discovery it has been found in more than one-half the counties of the state, and has been mined to a considerable extent in Alameda, Del Norte, Eldorado, Napa, Placer, San Luis Obispo, Shasta, Sonoma, Tehama, and Tuolumne counties. In 1886 the production of the eastern mines was 100 tons. Since that year they have been abandoned, the entire domestic product coming from California.

The product of chromic iron ore in the United States since 1880 has been as follows:

PRODUCTION OF CHROMIC IRON ORE IN THE UNITED STATES FROM 1880 TO 1889, INCLUSIVE.

| YEARS. | Quantity. (Long tons.) | Value. (*a*) |
|---|---|---|
| 1880 | 2, 288 | $27, 808 |
| 1881 | 2, 000 | 30, 000 |
| 1882 | 2, 500 | 50, 000 |
| 1883 | 3, 000 | 60, 000 |
| 1884 | 2, 000 | 35, 000 |
| 1885 | 2, 700 | 40, 000 |
| 1886 | 2, 000 | 30, 000 |
| 1887 | 3, 000 | 40, 000 |
| 1888 | 1, 500 | 20, 000 |
| 1889 | 2, 000 | 30, 000 |

*a* Subsequent to 1886 the value given is for ore delivered in San Francisco.

## FOREIGN SOURCES.

The principal foreign sources of chromic iron ore are Turkey, Russia, and Asia Minor, the last of which contains the largest known deposit in the world. This was discovered in 1848 by Professor J. Lawrence Smith, and is located near Brusa, a town 57 miles southeast of Constantinople. Another large deposit was discovered by him near Harmanjick, about 15 miles farther south, and still another field exists near Antioch. In these beds the ore occurs in masses rather than veins, being found in pockets in serpentine, similar to the deposits of California. The ore mined here is transported by camels to the seaports, whence it is shipped to England, Scotland, France, and the United States. The grade of this ore is higher than our domestic ore, large shipments averaging over 52 per cent of chromic oxide.

The Russian ores are found largely in the soapstones of the Ural mountains. Gustav Rose classifies them under 3 heads: (1) those which occur in large granular masses in serpentine, (2) those which are disseminated through rock, and (3) those found in platinum and gold washings. In Siberia it is found in masses, with lamellar or granular structure, at Orenboorg. It also occurs in extensive beds in Orsova, Drontheim, and Roeraas, Norway. Among other places where chromic iron ore occurs in workable quantities are New Zealand, New Caledonia, Victoria, New South Wales, and Queensland.

## IMPORTS.

The imports of chromic iron ore into the United States since 1884 have been as follows:

CHROMIC IRON ORE IMPORTED AND ENTERED FOR CONSUMPTION IN THE UNITED STATES FROM 1884 TO 1889, INCLUSIVE.

| YEARS ENDED— | Quantity. (Long tons.) | Value. |
|---|---|---|
| June 30, 1884 | 2, 677 | $73, 586 |
| 1885 | 12 | 239 |
| 1886 | 3, 356 | 43, 731 |
| 1887 | 1, 404 | 20, 812 |
| 1888 | 4, 440 | 46, 735 |
| Dec. 31, 1889 | 2, 875 | 27, 382 |

## USES.

As already stated, the production of this mineral is determined altogether by the demand for potassium bichromate and the corresponding sodium compound. Lately the manufacture of sodium bichromate has greatly increased. A small quantity of the ore is used in making chrome steel. Within the last 2 years a process has been gaining favor of making the lining of open-hearth steel furnaces of chromic iron ore. If this is generally introduced, it will completely change the condition of the industry, as the high quality desired where the ore is to be decomposed in making bichromates is not necessary in those for lining hearths. The run of the California mines can be shipped east and then sorted, the poorer ores going to the new use.

# ANTIMONY.

# ANTIMONY.

BY E. W. PARKER.

## PRODUCTION.

The amount of antimony ore produced in the United States in 1889 was 265 short tons. Of this amount 200 tons were mined in Nevada and 65 tons in Arkansas. The Nevada ore is smelted in San Francisco. That produced in Arkansas in 1889 was shipped to Philadelphia for reduction. The amount and value of the star regulus obtained from the ore was as follows:

AMOUNT AND VALUE OF STAR REGULUS PRODUCED IN THE UNITED STATES IN 1889.

| STATES. | Total ore smelted. (Short tons.) | Star regulus produced. (Short tons.) | Value. |
|---|---|---|---|
| Total | 265 | 115 | $28,000 |
| Arkansas | 65 | 25 | *a* 10,000 |
| Nevada | 200 | 90 | *b* 18,000 |

*a* At Philadelphia. *b* At San Francisco.

## CONDITION OF THE INDUSTRY.

The mining of antimony in Nevada is of a sporadic character, not carried on as a business or with any organized system, but the ore is taken out by residents at odd times, sold to storekeepers in the neighborhood, and by them shipped to San Francisco for smelting. The producing localities are in the vicinity of Humboldt, but the deposits are pockety and to a degree uncertain, which are the probable reasons why there has been no original effort at developing the properties. In Arkansas more systematic effort has been made and considerable development work has been accomplished. This work, however, was but a beginning in 1889, which accounts for the limited product.

## LABOR AND WAGES.

Owing to the irregular manner in which the mining of antimony ore in Nevada is carried on, it is impossible to give a statement of the labor and wages. The following figures are for the work done in Arkansas:

NUMBER OF EMPLOYÉS, WAGES, ETC., AT ANTIMONY MINES IN ARKANSAS IN 1889.

| CLASSIFICATION. | Number employed. | Average wages per day. | Average number of days worked. |
|---|---|---|---|
| Total | 28 | ........ | ........ |
| Above ground: | | | |
| Foremen | 2 | $2.00 | 275 |
| Laborers | 5 | 1.50 | 275 |
| Below ground: | | | |
| Foremen | 1 | 2.50 | 275 |
| Miners | 12 | 2.15 | 275 |
| Laborers | 8 | 1.50 | 275 |

WAGES AND OTHER EXPENDITURES AT ARKANSAS MINES IN 1889.

| | |
|---|---|
| Wages (including office force at the mines) | $12,218 |
| Paid contractors | 4,641 |
| Paid for supplies | 3,859 |
| Other expenses (rent, taxes, insurance, etc.) | 2,504 |
| Total expenditures (*a*) | 23,222 |

*a* Excess in expenditures over value of product is due to the large amount paid for development work.

## OTHER LOCALITIES.

Antimony occurs in Kern county, California, in a well-defined vein, but there are no records of any production since 1885. In Iron county, Utah, on Coyote creek, are some remarkable deposits of the mineral. A mine was opened there in 1880, and was worked somewhat during that year and 1881, but owing to the excessive cost of transportation and the low price of the metal the enterprise was not found profitable and was abandoned.

PRODUCTION OF ANTIMONY FROM 1882 TO 1889, INCLUSIVE.

| CALENDAR YEARS. | Amount of star regulus produced. (Short tons.) | Value. |
|---|---|---|
| 1882 | 60 | $12, 000 |
| 1883 | 60 | 12, 000 |
| 1884 | 60 | 12, 000 |
| 1885 | 50 | 10, 000 |
| 1886 | 35 | 7, 000 |
| 1887 | 75 | 15, 000 |
| 1888 | 100 | 20, 000 |
| 1889 | 115 | 28, 000 |

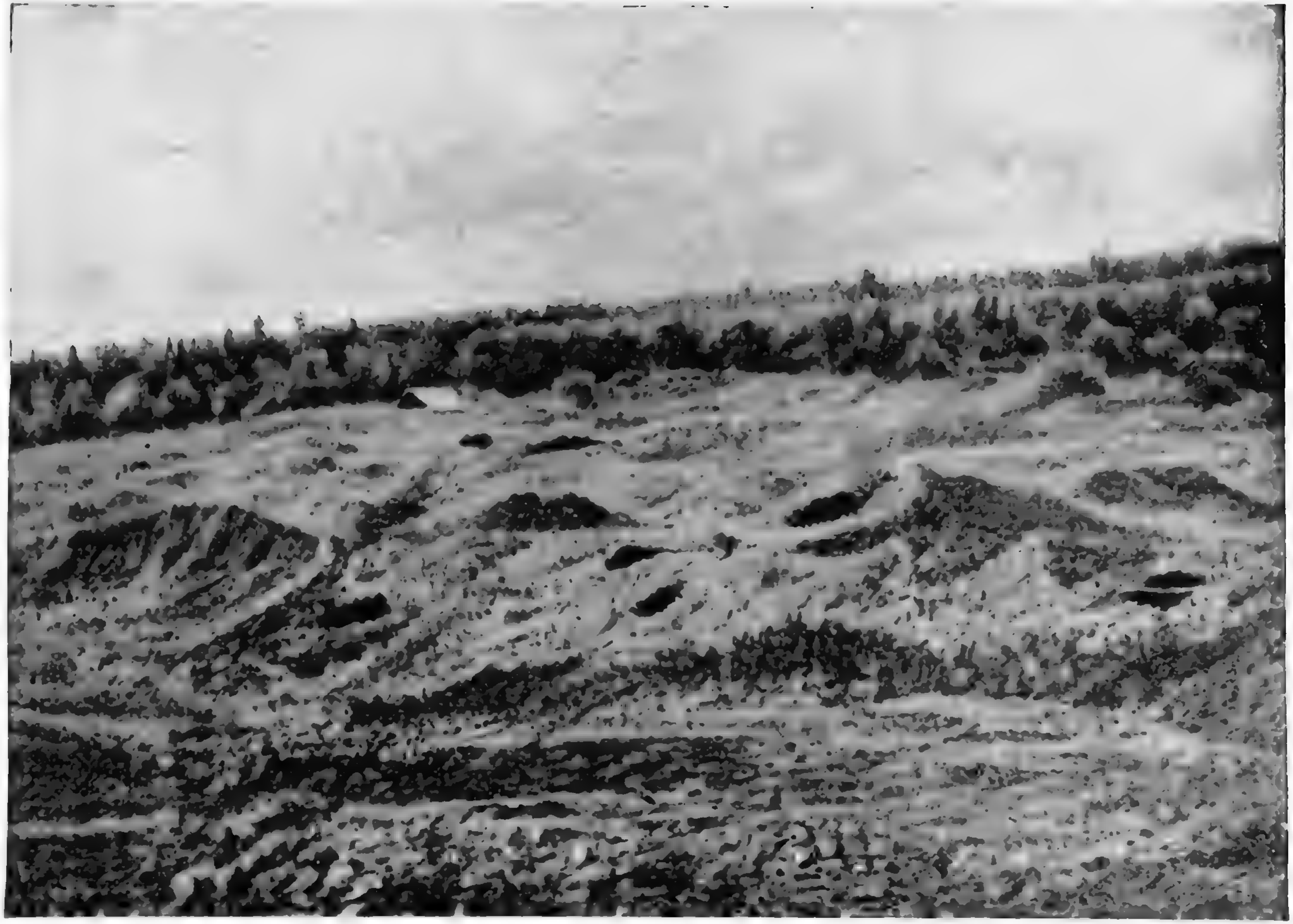
## USES.

Antimony is an important component in a number of alloys. Though brittle itself, it imparts a peculiar hardness and toughness to many of the softer metals. It is particularly useful in the manufacture of type metal with lead, the antimony not only giving hardness, which is essentially important, but causes an expansion of the alloy at the moment of solidifying, making the casting sharp and better formed in the mold. In making type metal from 17 to 20 per cent of antimony is used. Antimony is also used in the manufacture of britannia metal, babbitt metal, and pewter. It makes gold and silver brittle. Copper is curiously and injuriously affected by it. It is said that one-tenth of 1 per cent of antimony is enough to ruin a good quality of copper. Antimony is an element in a number of compounds used medicinally, tartar emetic being the most important. Pulverized antimony sulphide is used to some extent in the vulcanizing of rubber.

ANTIMONY AND ANTIMONY ORE IMPORTED AND ENTERED FOR CONSUMPTION IN THE UNITED STATES, 1867 TO 1889, INCLUSIVE.

| YEARS ENDED— | Total value. | CRUDE AND REGULUS. | | ORE. | |
|---|---|---|---|---|---|
| | | Quantity. (Pounds.) | Value. | Quantity. (Pounds.) | Value. |
| June 30, 1867 | $63, 919 | ............ | $63, 919 | ............ | ............ |
| 1868 | 83, 822 | 1, 033, 336 | 83, 822 | ............ | ............ |
| 1869 | 129, 918 | 1, 345, 921 | 129, 918 | ............ | ............ |
| 1870 | 164, 179 | 1, 227, 429 | 164, 179 | ............ | ............ |
| 1871 | 150, 628 | 1, 015, 039 | 148, 264 | ............ | $2, 364 |
| 1872 | 240, 567 | 1, 933, 306 | 237, 536 | ............ | 3, 031 |
| 1873 | 187, 439 | 1, 166, 321 | 184, 498 | ............ | 2, 941 |
| 1874 | 148, 612 | 1, 253, 814 | 148, 409 | ............ | 203 |
| 1875 | 131, 969 | 1, 238, 223 | 131, 360 | 6, 460 | 609 |
| 1876 | 120, 141 | 946, 809 | 119, 441 | 8, 321 | 700 |
| 1877 | 137, 631 | 1, 115, 124 | 135, 317 | 20, 001 | 2, 314 |
| 1878 | 132, 209 | 1, 256, 624 | 130, 950 | 20, 351 | 1, 259 |
| 1879 | 145, 440 | 1, 380, 212 | 143, 099 | 34, 542 | 2, 341 |
| 1880 | 268, 122 | 2, 019, 389 | 265, 773 | 25, 150 | 2, 349 |
| 1881 | 271, 253 | 1, 808, 945 | 253, 054 | 841, 730 | 18, 199 |
| 1882 | 312, 253 | 2, 525, 838 | 294, 234 | 1, 114, 699 | 18, 019 |
| 1883 | 298, 146 | 3, 064, 050 | 286, 892 | 697, 244 | 11, 254 |
| 1884 | 156, 924 | 1, 779, 337 | 150, 435 | 231, 360 | 6, 489 |
| Dec. 31, 1885 | 214, 712 | 2, 579, 840 | 207, 215 | 215, 913 | 7, 497 |
| 1886 | 212, 324 | 2, 997, 985 | 202, 563 | 218, 366 | 9, 761 |
| 1887 | 178, 532 | 2, 553, 284 | 169, 747 | 368, 761 | 8, 785 |
| 1888 | 250, 193 | 2, 814, 044 | 248, 015 | 68, 040 | 2, 178 |
| 1889 | 310, 279 | 2, 676, 130 | 304, 711 | 146, 309 | 5, 568 |

# PLATINUM AND IRIDIUM.



OLD PLATINUM WASHING, NISJNE TAGILSK, EUROPEAN RUSSIA.

(Platinum layer 15 feet below the surface.)

# PLATINUM AND IRIDIUM.

The gold-bearing placers of the Pacific coast have long been known to contain iridosmine and other alloys of platinum, osmium, iridium, and others of this group of metals. The grains of iridosmine and flakes of malleable alloys are found in the heavier sands in the undercurrents and riffles in placer mining. As the metal does not amalgamate, it has not usually been saved. In cases where unusual efforts have been made to collect platinum the miners have frequently met with decided disappointment in obtaining a remunerative price; hence little attention is paid to its occurrence, although small amounts are sent irregularly to dealers in San Francisco, who consign the grains to refiners in New York, Newark, or Philadelphia, or to London. In this way 500 ounces of crude material, worth about $2,000 in San Francisco, were collected in 1889. Of course no statistics of expenses for labor and wages are attainable for this product, as it is always produced as a minor feature in mining gold-bearing placers.

## USES.

The principal uses to which this metal is put are the manufacture of crucibles for chemists; quite an extensive use in the manufacture of incandescent electric lights, the connecting wire to the carbon film from which the light is given being of this metal; in the manufacture of artificial teeth, and to a slight extent in the manufacture of jewelry. At one time it was used in coinage in Russia, but owing to the great range of its price commercially this use was abandoned. The metal has been of great importance for crucibles and other chemical apparatus, owing to its high fusing point, being 3,080° fahrenheit.

## FOREIGN SOURCES.

The principal source of platinum in the world is Russia, where it occurs in large quantities in the Ural mountains. Originally it was produced here as a by-product of gold mining, as is now done on the Pacific coast; but during late years the gold has become scarce and the platinum has become the principal product of the mines.

The following is a table of the production of platinum in Russia from 1880 to 1887, compiled from the best authorities obtainable:

PRODUCTION OF PLATINUM IN RUSSIA FROM 1880 TO 1887, INCLUSIVE.

| YEARS. | Quantity. (Kilograms.) | YEARS. | Quantity. (Kilograms.) |
|---|---|---|---|
| 1880 | 2,947 | 1884 | 2,237 |
| 1881 | 2,986 | 1885 | 2,591 |
| 1882 | 4,081 | 1886 | 4,317 |
| 1883 | 3,537 | 1887 | 4,242 |

Besides Russian platinum, a small but regular quantity is produced by the French in La República de Colombia. Deposits of this material also occur in Canada and Mexico, but as yet they have not proved commercial factors in its production.

## PRICE.

The price of platinum has fluctuated very greatly between 1880 and 1889. In 1880 it was as low as $5.49 an ounce, while at the close of 1889 it was about $14 an ounce, and has since risen much higher. This rapid rise in the price is partly attributed to the operations of a syndicate, the decrease in the amount of the ore, and to the fact that labor has become very scarce. According to the Journal of the Society of Chemical Industry, London, England, the product of the Ural platinum mines for the coming 10 years has been sold to certain foreign companies, presumably the syndicate interested in this metal.

The principal supply of platinum is from the two small districts on the slopes of the Ural mountains on the Siberian side. The districts are about 100 miles apart. Each consists of several dried but recent river beds. The northern district, called the Isa, is made of river beds making a local part of the Isa river drainage system.

The other district is composed of similar dry tributaries to the Martin (Martian) river. This district is called the Nisjne Tagilsk district, from the principal village. Both of the districts have been worked for many years. Probably both were originally gold placers, but if so there is nothing to show it, as they are worked for platinum pure and simple. Much has been written, founded largely on guesswork, as to the working of these mines, and to the effect that the rise in the price of platinum is due to failure of the accompanying gold. Whether or not the gold was found and did bear part of the expense, this explanation is of no value, because the producing conditions are now about as they were before platinum rose in value.

The information about these mines has been meager. Fortunately, however, Mr. George F. Kunz has made, at his own inspiration, a trip to this out-of-the-way region, and, making light of sickness and the irksome features of the journey, by untiring efforts against the habitual secrecy of the managers has obtained more information than has been published since the similar journey of von Humboldt. Mr. Kunz was not aided by the government in any way, but arranged to return to the United States just as the report is going through the final revision, and has courteously contributed his difficultly-gotten knowledge to the census report, in order that it may add something to the chance of obtaining platinum in the placers in the United States.

The two districts mentioned above are worked in a similar way, although the northern, Goro-Blagodat, or Isa region is under government control, and the Nisjne Tagilsk or Demidoff district, on the Martin river, is a part of the Demidoff estate, and worked as a purely business enterprise. The Demidoff estate was granted to the prince in order that these placers should be worked.

As shown by the accompanying illustration the deposits are simply placers composed of serpentine and other bowlders mixed with chromic iron ore, etc. A favorable flat bed rock is reached at about 30 to 40 feet from the surface, and the platinum sand is found for a depth of 6 to 10 inches on this bed rock. The deposits are opened by shafts to the bed rock and tunnels and side drifts, often 300 feet long, on the bed rock. This tunneling protects the miners in winter. There are hundreds of miles of tunnels on the Demidoff estate. The sand is excavated and piled in the winter and washed in the summer. The process of washing is shown in the accompanying illustration.

On the Demidoff estate there are 3 large washing plants, and a dam for a fourth is being built. Besides this there are many individual workings by peasants, who open small shafts and tunnels to a bed rock and pan the platinum. They give two-thirds to the estate and sell the other third.

The accompanying illustration gives a general view of one of the three simple washing plants. Carts containing about 1,500 pounds of the pay sand are hauled on the bridge and the contents dumped into a revolving screen below. The small stuff is washed by water. It is stirred by 2 women. The heavier sand, chromite, etc., collects in the riffles. This is worked over again, and the tailings are also washed once more. The machines are run by steam and worked day and night for about half the year. The employés work in shifts of 12 hours each, the day shift working from 6 a. m. to 6 p. m., with 4 hours rest. The night shift also takes 4 hours for rest. The law regarding 8 hours' work is very stringent. The two shifts handle in the course of 24 hours 1,200 loads, or 720 short tons of sand, producing 2.7 pounds of platinum. The daily clean up of the Demidoff estate is about 9 pounds of platinum, including the irregular miners. The wagon driver gets for himself, horse, and cart 1 ruble and 30 kopecks, or from 82 to 90 cents per day, for which he is expected to haul 60 loads. The washing is largely done by women, who get 40 kopecks (20 to 23 cents) a day. The men get 70 kopecks (35 to 40 cents).

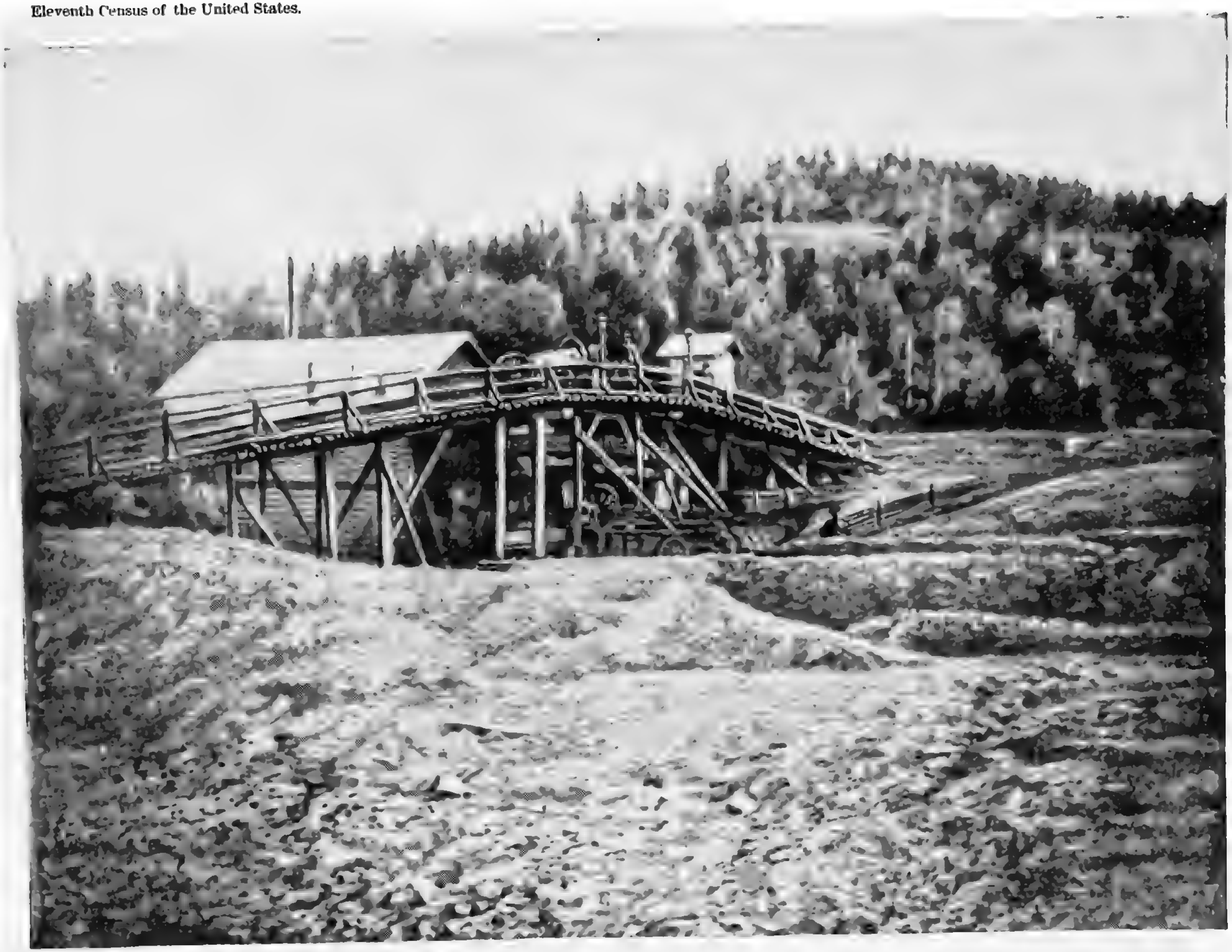
DAILY EXPENSE, ETC., OF PLATINUM WASHING IN RUSSIA.

| | RUBLES. |
|---|---|
| 40 horses, carts, and drivers, at 1 ruble 30 kopecks | 52.00 |
| 16 workmen, at 70 kopecks | 11.20 |
| 4 women, at 40 kopecks | 1.60 |
| For one machine | 64.80 |
| Total for the district per day | 194.40 |
| Total milling cost for the year (180 days worked) | a34,992.00 |

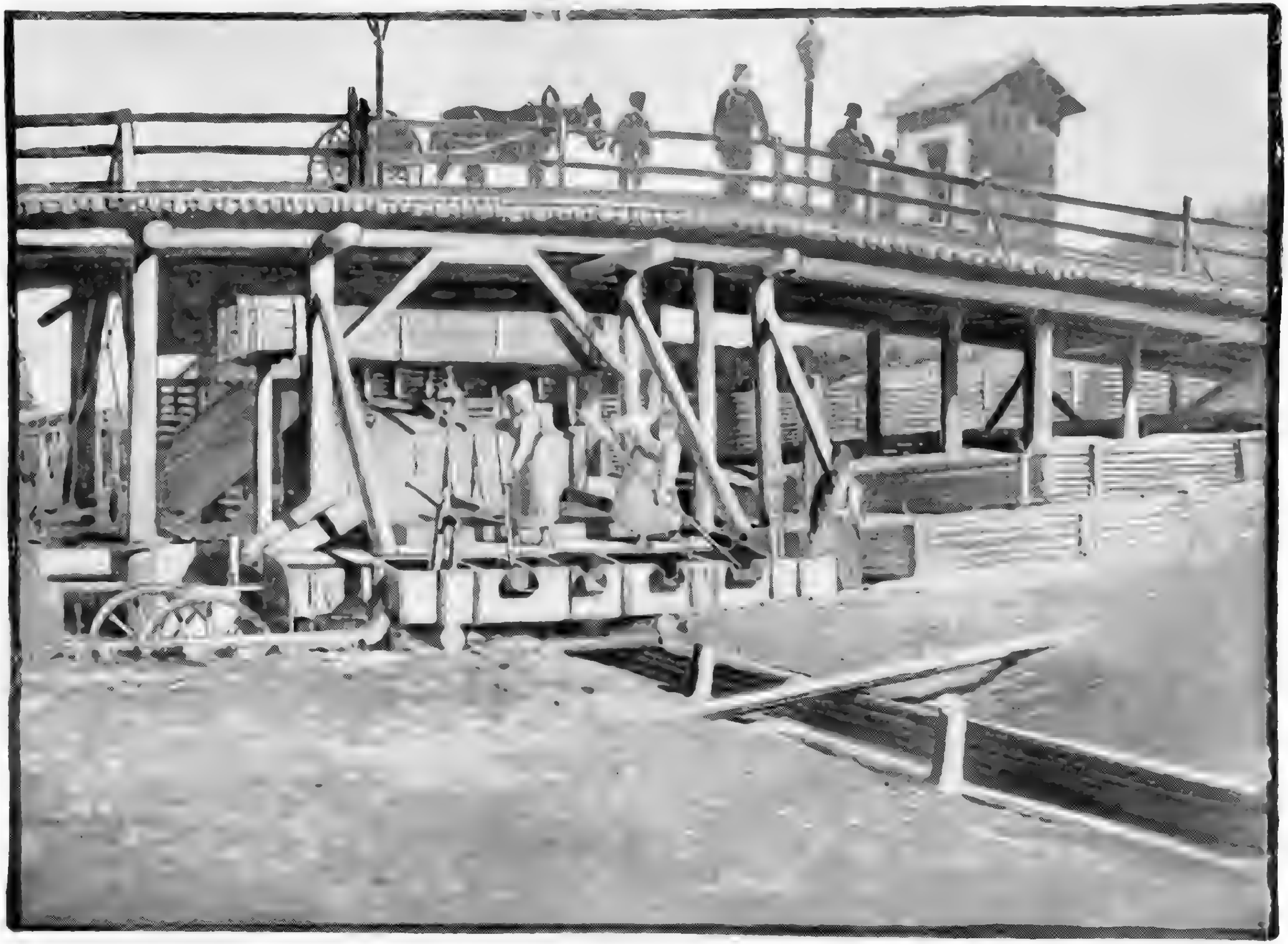
a $26,244.

The above cost is of course only for the washing. The cost of hoisting and piling the pay sand has not been obtained. The platinum thus produced is about 80 per cent pure, and is worth 8,000 rubles per pood (36 pounds avoirdupois) or $10 per ounce. It is all purchased by a contract which still has 3 years to run.

The yearly product of the district amounts to 1,620 pounds avoirdupois, which, at 222 rubles per pound, has a total value of 359,640 rubles.

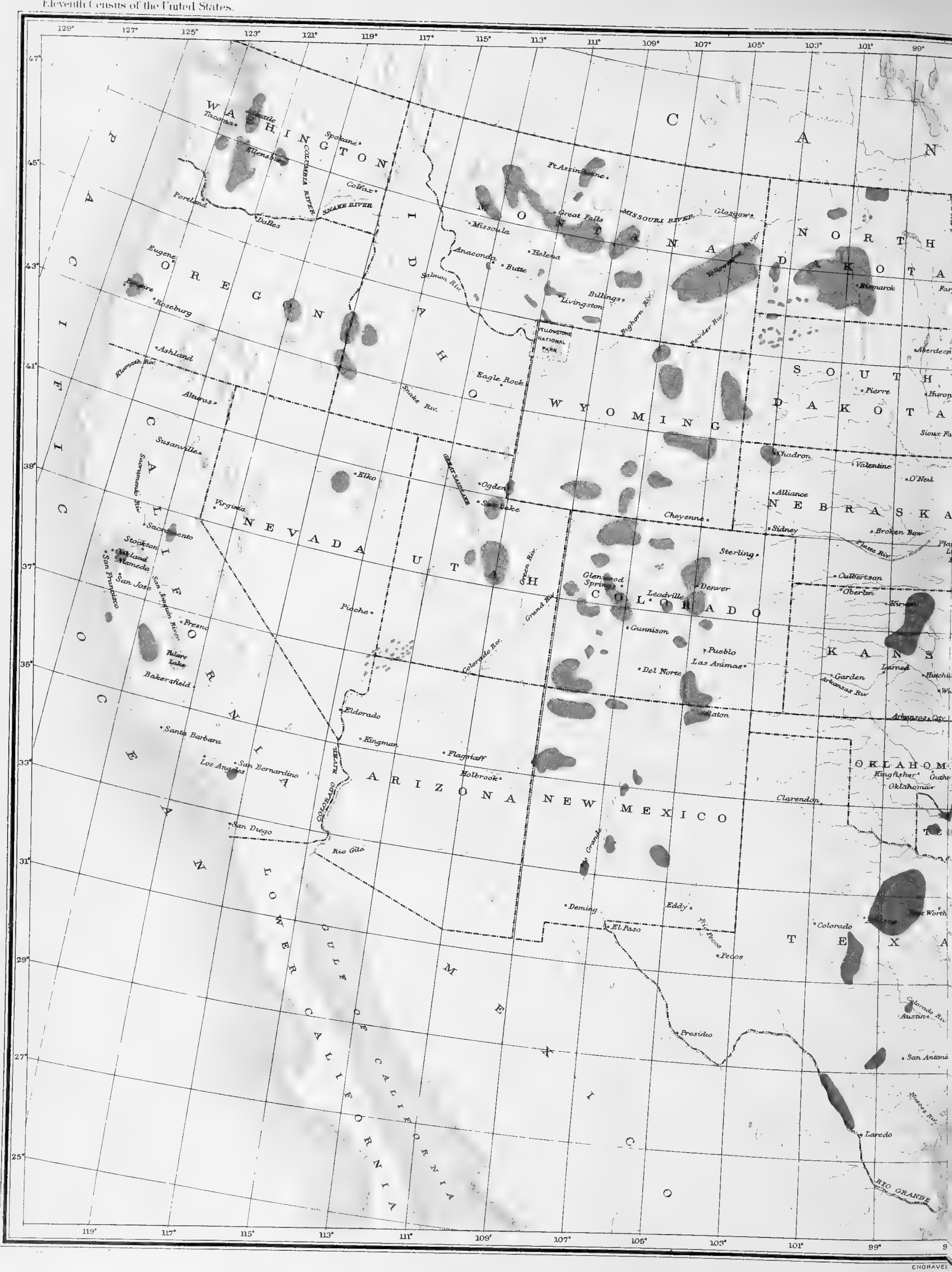


PLATINUM WASHING MACHINE, DEMIDOFF ESTATE, NISJNE TAGILSK, EUROPEAN RUSSIA.



WASHING PLATINUM SAND, DEMIDOFF ESTATE, NISJNE TAGILSK, EUROPEAN RUSSIA.

# COAL.


129°
127°
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121°
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117°
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113°
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109°
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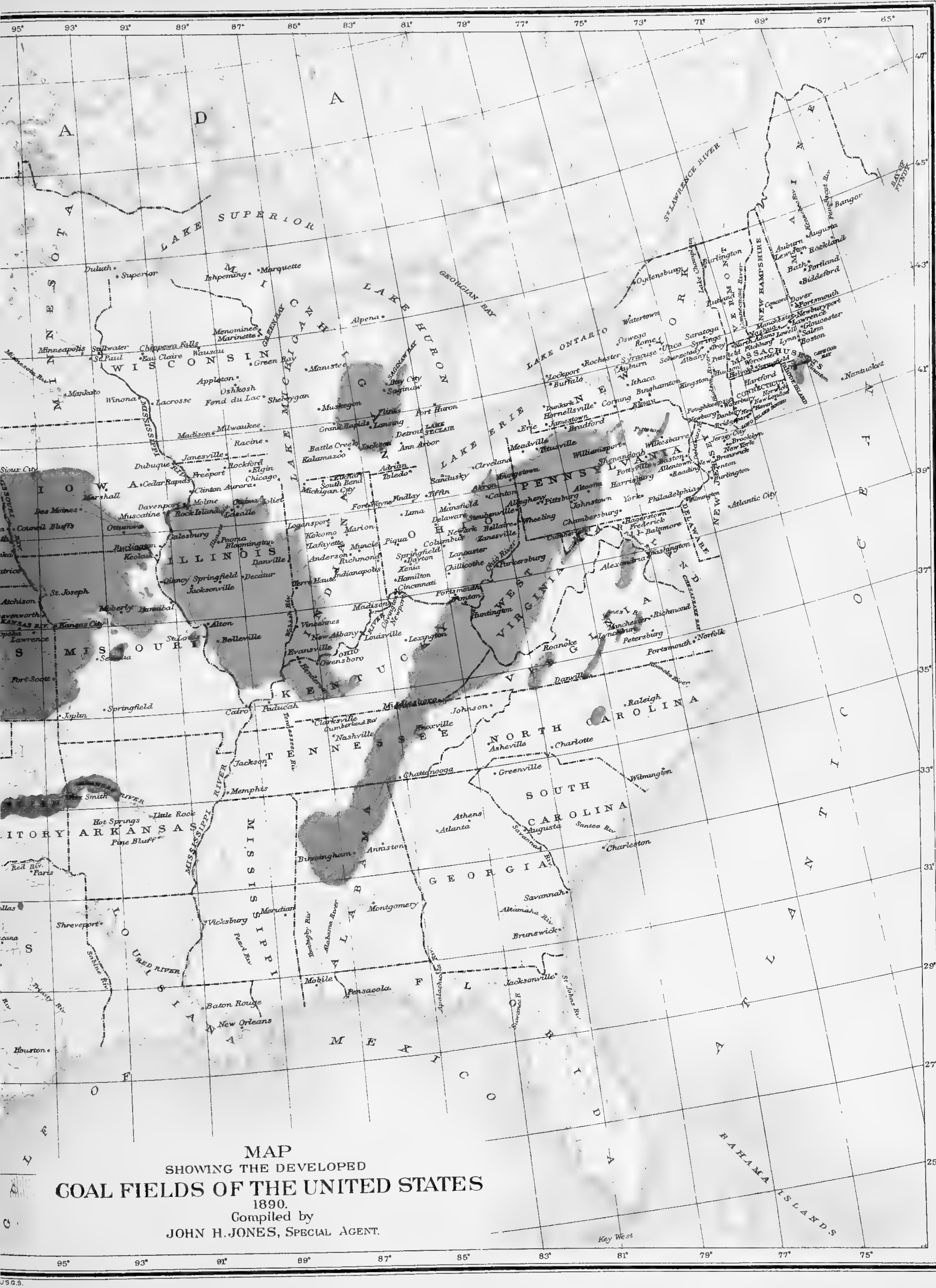
105°
103°
101°
99°
47°
45°
43°
41°
39°
37°
35°
33°
31°
29°
27°
25°
C A N
W A S H I N G T O N
Seattle
Tacoma
Spokane
Ellensburg
COLUMBIA RIVER
SNAKE RIVER
Colfax
Portland
Dalles
P A C I F I C O C E A N
O R E G O N
Eugene
Empire
Roseburg
Ashland
Klamath Riv.
I D A H O
Salmon Riv.
Snake Riv.
Eagle Rock
M O N T A N A
Ft. Assinniboine
Great Falls
MISSOURI RIVER
Glasgow
Missoula
Anaconda
Helena
Butte
Billings
Livingston
Bighorn Riv.
Powder Riv.
Yellowstone River
YELLOWSTONE NATIONAL PARK
N O R T H D A K O T A
Bismarck
Far
S O U T H D A K O T A
Aberdeen
Pierre
Huron
Sioux Fa
W Y O M I N G
Chadron
Cheyenne
Valentine
O'Neil
Alliance
Sidney
N E B R A S K A
Broken Bow
Platte Riv.
Pla
C A L I F O R N I A
Alturas
Susanville
Sacramento Riv.
Sacramento
Stockton
Oakland
Alameda
San Francisco
San Jose
San Joaquin River
Fresno
Tulare Lake
Bakersfield
Santa Barbara
Los Angeles
San Bernardino
San Diego
N E V A D A
Virginia
Elko
Pioche
U T A H
GREAT SALT LAKE
Ogden
Salt Lake
Green Riv.
Grand Riv.
Colorado Riv.
C O L O R A D O
Glenwood Springs
Leadville
Denver
Sterling
Gunnison
Pueblo
Las Animas
Del Norte
Raton
Culbertson
Oberlin
K A N S
Kirwin
Garden
Arkansas Riv.
Larned
Hutchi
Arkansas City
A R I Z O N A
Eldorado
Kingman
Flagstaff
Holbrook
COLORADO RIVER
Rio Gila
N E W M E X I C O
Rio Grande
Deming
Eddy
El Paso
Rio Pecos
Pecos
Clarendon
O K L A H O M
Kingfisher
Guthr
Oklahoma
TE
T E X A
Colorado
Fort Worth
Colorado Riv.
Austin
Presidio
San Antoni
Nueces Riv.
Laredo
RIO GRANDE
L O W E R C A L I F O R N I A
GULF OF CALIFORNIA
M E X I C O
119°
117°
115°
113°
111°
109°
107°
105°
103°
101°
99°
9

ENGRAVE



# MAP
SHOWING THE DEVELOPED
# COAL FIELDS OF THE UNITED STATES
1890.
Compiled by
JOHN H. JONES, SPECIAL AGENT.

U.S.G.S.

# COAL.

BY JOHN H. JONES.

The statistics of the Eleventh Census show that coal was mined in 31 states and territories, including Alaska and Rhode Island, although the product of the latter has not been used for fuel, and therefore has only been mined to a limited extent for special industrial purposes, such as the production of steel by a sponge process. Pennsylvania, containing the well-known beds of anthracite coal, as well as extensive deposits of bituminous coal, yielded 57.86 per cent of the entire output of the country. Illinois, with bituminous deposits alone, ranks second as a coal producer, Ohio, West Virginia, Iowa, and Alabama following in the order named.

The coal deposits of the United States lying east of the one hundredth meridian are identified in 4 distinct and well-defined basins, viz, the great Appalachian, or Eastern, including the anthracite beds in Pennsylvania; the Central, or Illinois; the Northern, or Michigan, and the Fourth, or Western, all of which belong to the carboniferous measures.

The following descriptions of the coal fields of the United States are compiled from a report by the late Dr. Charles A. Ashburner to the United States geological survey:

> The anthracite coal fields of Pennsylvania are confined to the following counties in the northeastern part of the state: Carbon, Columbia, Dauphin, Lackawanna, Luzerne, Northumberland, Schuylkill, Sullivan, and Susquehanna. The area of the entire region is about 1,700 square miles. The area underlaid by workable coal beds is only about 470 square miles. The natural geological and topographical boundaries of this area are formed by the mountains and ridges made by the Pocono sandstone, No. X. No workable coal beds have been found stratigraphically below the Pottsville conglomerate, No. XII, the Lykens Valley or lowest anthracite beds being found in the latter formation. The greatest length of the region, from the northeastern end of the northern field to the southwestern end of the southern field, is about 115 miles, while the greatest width of the belt containing the first 4 fields is about 40 miles, between Mauch Chunk and Shickshinny, near the western end of the northern field.
>
> The Appalachian bituminous field lies immediately west of the eastern frontier of the Appalachian mountains, and extends from New York state on the north to Alabama on the south. Its length is a little over 900 miles in a northeast and southwest direction, and its width varies from 30 to 180 miles. It covers western Pennsylvania, southeastern Ohio, the western part of Maryland, nearly all of West Virginia, the eastern part of Kentucky, a portion of eastern Tennessee, the extreme northwestern corner of Georgia, and the northern part of Alabama. All of the coals in this field are bituminous, and they are of great variety, both in chemical composition and physical structure. Although it is difficult to make any general comparisons, the best and most productive coal beds lie probably in the Pittsburg district and in West Virginia. Some of the best coals in the district are mined in basins detached from the main body of the field, such as the Blossburg and Broad Top basins in Pennsylvania and the Cumberland in Maryland.
>
> What is known as the eastern triassic area is composed principally of the Richmond basin in Virginia and the Deep River and Dan River fields in North Carolina. The first coal systematically mined in the United States was taken from the Richmond basin. In 1822 about 48,214 tons of coal were produced, which was 12 times the total amount of coal shipped during that year from the Pennsylvania anthracite region. The maximum production of the field was in 1833, when 142,587 tons of coal were shipped. This was nearly one-third the total amount of Pennsylvania anthracite shipped during the same year. Mining in this field has gradually declined during the past 2 or 3 years, and no extensive operations are now carried on. A number of workable beds have been found in North Carolina, which have been worked at different times, principally to supply local demands.
>
> A deposit of graphitic coal, sometimes called anthracite, underlies portions of eastern Rhode Island and the counties of Bristol and Plymouth in Massachusetts. The product, however, has been proved not so suitable for fuel.
>
> The northern bituminous area is confined exclusively to Michigan, spreading over the central part of that state. Although several coal beds are found within the area of this field, which has been computed to be 7,000 square miles, much better coal has been obtained in adjoining fields. Mining has been carried on in this district principally for the supply of fuel to the local trade. The numerous transportation routes, both by water and rail, to more distant fields containing better coal has militated against the development of the Michigan coal basin.
>
> The central field includes the coal areas of Indiana, Illinois, and western Kentucky. On account of Illinois containing the most important part of the field, it is frequently called the Illinois field. That portion of the field in Illinois is over 5 times as great as that in Indiana, and over 9 times as great as that in western Kentucky.
>
> The western field embraces the coal fields west of the Mississippi river, south of the forty-third parallel, and east of the Rocky mountains. It is embraced within the states of Iowa, Missouri, Nebraska, Kansas, Arkansas, Texas, and the Indian territory. The most extensive mining operations in this field are carried on in Iowa and Missouri. The best coal which has so far been mined in the field is that from Indian territory. The area of this field is greater than any other one coal field in the United States. The coals are of great variety, and the region under which they lie is a rich agricultural country. The demand for local fuels must necessarily increase from year to year, so that even poor coal beds within this region will no doubt be extensively developed to supply local demands.
>
> In the Rocky mountain district coal beds are found in a number of geological formations. In the fields above referred to, with the exception of those in Virginia and North Carolina, the coal beds belong to the carboniferous age. The Rocky mountain coal beds have been found in the geological formations from the carboniferous up to and including the cretaceous. No detailed information of the entire coal area of the Rocky mountain region, similar to that which has been determined by state geological surveys of the coal basins east of the Rocky mountains, is available, and no reliable estimates have been made of the areas underlaid by workable coal beds. It has been surmised that the total area of the coal fields of this district is between 200,000 and 300,000 square miles, but this estimate is little more than a guess.
>
> The anthracite coals of Colorado and New Mexico are of a superior quality and apparently in ample supply for the rapidly increasing domestic and industrial demands of this section. There is no doubt that in the near future they will constitute a formidable competitor in the western markets to the Pennsylvania anthracites.

In the Pacific Coast region coal has been mined in Washington, Oregon, and California. The area underlaid by workable coal beds has not been definitely determined, although the geological survey of California and the recent work of Professor Raphael Pumpelly and his associates in Washington have given very reliable and detailed information in regard to the geology of the coal-bearing rocks.

The following table shows the number of square miles in each of these basins from the latest and most reliable authorities, together with the quantities of coal mined in each in the calendar year 1889, as reported to the Eleventh Census:

AREA AND PRODUCT OF THE COAL FIELDS OF THE UNITED STATES.

| FIELDS. | ELEVENTH CENSUS. | | TENTH CENSUS. | |
|---|---|---|---|---|
| | Area. (Square miles.) | Production. (Short tons.) | Area. (Square miles.) | Production. (Short tons.) |
| Grand total | .......... | 141, 229, 513 | .......... | 71, 481, 570 |
| ANTHRACITE. | | | | |
| New England basin (Rhode Island and Massachusetts). | 500 | 2, 000 | 500 | 6, 176 |
| Pennsylvania | 470 | 45, 544, 970 | 470 | 28, 640, 819 |
| Virginia | .......... | .......... | .......... | 2, 817 |
| Colorado and New Mexico | 15 | 53, 517 | .......... | .......... |
| Total | 985 | 45, 600, 487 | 970 | 28, 649, 812 |
| BITUMINOUS. | | | | |
| Triassic: | | | | |
| Virginia | 185 | 49, 411 | 180 | 40, 520 |
| North Carolina | 2, 700 | 222 | 2, 700 | 350 |
| Total | 2, 885 | 49, 633 | 2, 880 | 40, 870 |
| Appalachian: | | | | |
| Pennsylvania | 9, 000 | 36, 174, 089 | 9, 000 | 18, 425, 163 |
| Ohio | 10, 000 | 9, 976, 787 | 10, 000 | 6, 008, 595 |
| Maryland | 550 | 2, 939, 715 | 550 | 2, 228, 917 |
| Virginia | 2, 000 | 816, 375 | 185 | 2, 559 |
| West Virginia | 16, 000 | 6, 231, 880 | 16, 000 | 1, 829, 844 |
| Eastern Kentucky | 10, 000 | 1, 108, 770 | 9, 000 | 365, 797 |
| Tennessee | 5, 100 | 1, 925, 689 | 5, 100 | 495, 131 |
| Georgia | 200 | 225, 934 | 200 | 154, 644 |
| Alabama | 8, 660 | 3, 572, 983 | 8, 660 | 323, 972 |
| Total | 61, 510 | 62, 972, 222 | 58, 695 | 29, 834, 622 |
| Northern: | | | | |
| Michigan | 7, 000 | 67, 431 | 6, 700 | 100, 800 |
| BITUMINOUS—continued. | | | | |
| Central: | | | | |
| Indiana | 7, 000 | 2, 845, 057 | 6, 450 | 1, 454, 327 |
| Western Kentucky | 4, 000 | 1, 290, 985 | 4, 000 | 580, 491 |
| Illinois | 37, 000 | 12, 104, 272 | 36, 800 | 6, 115, 377 |
| Total | 48, 000 | 16, 240, 314 | 47, 250 | 8, 150, 195 |
| Western: | | | | |
| Iowa | 18, 000 | 4, 095, 358 | 18, 000 | 1, 461, 116 |
| Missouri | 26, 900 | 2, 557, 823 | 26, 887 | 844, 304 |
| Nebraska | 3, 200 | 2, 222, 443 | 3, 000 | 771, 642 |
| Kansas | 17, 000 | | 17, 000 | |
| Arkansas | 9, 100 | 279, 584 | 9, 043 | 14, 778 |
| Indian territory | 20, 000 | 752, 832 | 20, 000 | *a* 120, 947 |
| Texas | 4, 500 | 128, 216 | 4, 500 | .......... |
| Total | 98, 700 | 10, 036, 256 | 98, 430 | 3, 212, 787 |
| Rocky Mountain. | | | | |
| Dakota | .......... | 28, 907 | .......... | .......... |
| Montana | .......... | 363, 301 | .......... | 224 |
| Wyoming | .......... | 1, 388, 947 | .......... | 589, 595 |
| Utah | .......... | 236, 651 | .......... | 14, 748 |
| Colorado | .......... | 2, 544, 144 | .......... | 462, 747 |
| New Mexico | .......... | 486, 463 | .......... | .......... |
| Total | .......... | 5, 048, 413 | .......... | 1, 067, 314 |
| Pacific Coast: | | | | |
| Washington | .......... | 1, 030, 578 | .......... | 145, 015 |
| Oregon | .......... | 64, 359 | .......... | 43, 205 |
| California | .......... | 119, 820 | .......... | 236, 950 |
| Total | .......... | 1, 214, 757 | .......... | 425, 170 |

*a* Not returned in the Tenth Census reports.

The following table shows the production, value, number of persons employed, wages paid, and capital invested in the coal establishments of the country at the Eleventh Census as compared with the Tenth Census:

COMPARATIVE SUMMARY OF THE COAL INDUSTRY AT THE ELEVENTH AND TENTH CENSUSES.

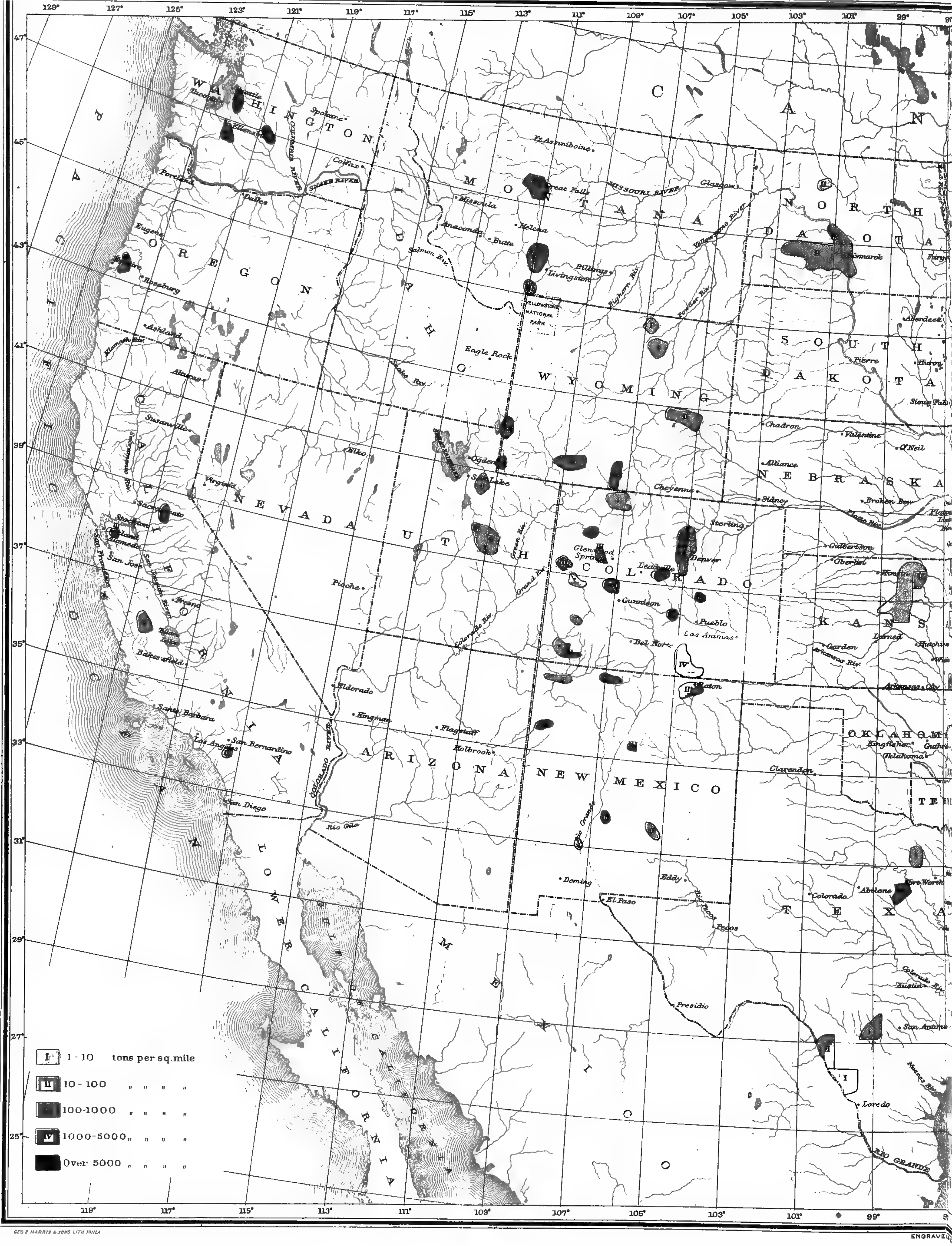
| CENSUSES. | Product. (Short tons.) | Value at mines. | Number of persons employed. | Amount of wages paid. | Capital invested. |
|---|---|---|---|---|---|
| Eleventh | 141, 229, 513 | $160, 226, 323 | 299, 559 | $109, 130, 928 | *a*$342, 757, 929 |
| Tenth | *b*71, 481, 570 | 95, 640, 396 | 170, 867 | 55, 276, 055 | *c*261, 166, 970 |
| Increase | 69, 747, 943 | 64, 585, 927 | 128, 692 | 53, 854, 873 | 81, 590, 959 |
| Per cent | 97. 57 | 67. 53 | 75. 32 | 97. 43 | 31. 24 |

*a* In the capital invested reported for the Eleventh Census only the lands actually under development are considered.

*b* Including Indian territory, not returned in the Tenth Census reports.

*c* This amount includes estimated value of undeveloped coal lands.

The total product of coal, 141,229,513 short tons, valued at $160,226,323 at the mines, includes 45,600,487 tons of Pennsylvania and other anthracite, valued at $65,879,514, or an average of $1.58 per short ton, at the mines, and 95,629,026 short tons bituminous and lignite, valued at $94,346,809, or an average of $0.99 per short ton, at the mines. In determining the average value of the anthracite at the mines the product of the local mines is included, but no account has been taken of the coal consumed for steam and heat about the mines, because this fuel consists generally of culm and other unsalable qualities, and is not included in the accounts of operators, having been for the most part estimated for the purposes of this report. In establishing the average price received at the mines for bituminous and lignite, however, the entire product, including that from the local mines, as well as that used for steam or heat about the mines, was considered, as the coal used for mining purposes is of the same quality as that



GEO S HARRIS & SONS LITH PHILA

ENGRAVE

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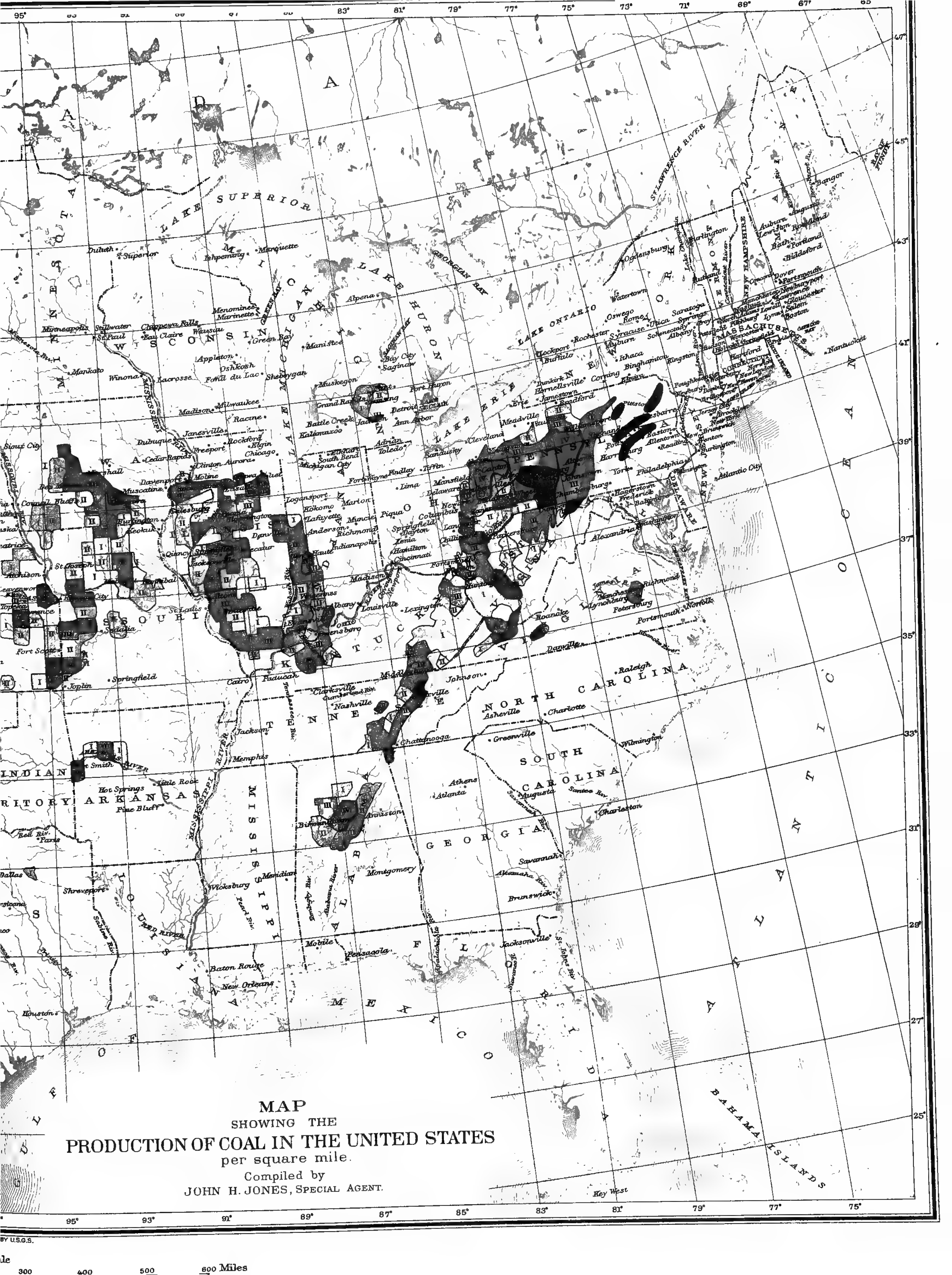


MAP
SHOWING THE
PRODUCTION OF COAL IN THE UNITED STATES
per square mile.
Compiled by
JOHN H. JONES, SPECIAL AGENT.

sold in the market. The total number of regular establishments reported in operation during the year was 2,583; the number of local mines and farmers' banks, 9,969. The "regular establishments" include all collieries equipped for shipping coal regularly by rail or water, together with the more important collieries supplying local trade. The returns from "local mines and farmers' banks" were obtained by special agents resident in the respective districts, and are, therefore, complete.

The total quantity of coal produced at these small mines was 2,889,286 short tons, or 2.05 per cent of the total output. The average total number of persons employed in the coal-mining operations of the country during 1889 was 299,552, which includes superintendents, mechanics, clerical force pertaining to collieries, miners, laborers, drivers, and slate pickers. The average number of days in the year when collieries were shipping coal was 193, based upon the average of each state, respectively. No attempt has been made to determine an average of days worked or wages paid at the small mines because of the irregular methods prevailing and the entire absence of any records beyond the quantities sold and consumed and the customary price received, and this in many cases was approximated. The total amount paid in wages during 1889 (except at the local mines) was $112,286,099, including amounts paid for "dead" work, such as driving tunnels and gangways, constructing buildings, and other work of a general character done by contract, not enumerated in the tables of "Labor and wages", together with the annual or monthly salaries of the administrative and clerical force connected with the collieries.

The grand total of expenditures of every description, including labor as above stated, materials of all kinds used in mining and preparing the coal, rents, royalties, interest, etc., was $146,536,280. It must be borne in mind, however, that this amount includes dead work and supplies, such as rails, props, mine cars, etc., paid for in 1889, which are available for the operations of the future.

The total invested capital, as reported to the census, was $342,757,929. This amount includes the estimated value in 1889 of the land actually under development (omitting all acreage held in reserve for future operations), the estimated value of the buildings (except domiciles and storehouses), fixtures, machinery, animals, implements, and supplies on hand, also the amount of actual working capital necessary for the prosecution of the business.

GENERAL STATISTICS OF COAL MINING IN THE UNITED STATES AT THE ELEVENTH CENSUS.

| STATES AND TERRITORIES. | MINES. |  | Total production of coal in 1889. (Short tons.) | Total amount received for coal. | Average price per ton. | Total number of employés. | EXPENDITURES. |  | Capital invested. |
|---|---|---|---|---|---|---|---|---|---|
|  | Regular. | Local. (*a*) |  |  |  |  | Total of wages paid. | Total of all expenditures. |  |
| Grand total | 2,583 | 9,969 | 141,229,513 | *b*$160,226,323 | *b*$1.17 | 299,552 | $109,130,928 | $146,536,280 | $342,757,929 |
| Bituminous: |  |  |  |  |  |  |  |  |  |
| Alabama | 57 | 22 | 3,572,983 | 3,961,491 | 1.11 | 6,975 | 3,267,857 | 3,726,939 | 12,535,194 |
| Arkansas | 11 | 16 | 279,584 | 395,836 | 1.42 | 686 | 252,679 | 308,711 | 1,289,751 |
| California and Oregon | 9 | 1 | 184,179 | 434,382 | 2.36 | 419 | 248,449 | 364,942 | 526,750 |
| Colorado | 63 | 40 | 2,544,144 | 3,843,992 | 1.51 | 4,872 | 2,724,800 | 3,695,298 | 12,611,849 |
| Illinois | 358 | 714 | 12,104,272 | 11,755,203 | 0.97 | 24,323 | 8,634,347 | 10,366,069 | 17,630,351 |
| Indiana | 94 | 256 | 2,845,057 | 2,887,852 | 1.02 | 6,532 | 2,201,044 | 2,581,669 | 3,435,703 |
| Indian territory | 15 | ....... | 752,832 | 1,323,807 | 1.76 | 1,873 | 927,267 | 1,172,821 | 1,492,009 |
| Iowa | 166 | 226 | 4,095,358 | 5,426,509 | 1.33 | 9,384 | 3,956,788 | 4,732,950 | 6,279,179 |
| Kansas and Nebraska | 127 | 297 | 2,222,443 | 3,301,788 | 1.49 | 6,069 | 2,320,588 | 2,730,782 | 3,488,539 |
| Kentucky | 79 | 1,762 | 2,399,755 | 2,374,339 | 0.99 | 5,260 | 1,756,363 | 2,156,548 | 6,581,380 |
| Maryland | 31 | 50 | 2,939,715 | 2,517,474 | 0.86 | 3,741 | 1,730,687 | 2,061,058 | 18,025,367 |
| Michigan | 6 | 6 | 67,431 | 115,011 | 1.71 | 265 | 93,594 | 113,714 | 49,650 |
| Missouri | 122 | 356 | 2,557,823 | 3,479,057 | 1.36 | 6,730 | 2,538,273 | 2,846,137 | 3,992,293 |
| Montana | 8 | 22 | 363,301 | 880,773 | 2.42 | 857 | 587,538 | 649,674 | 1,153,076 |
| New Mexico | 17 | 11 | 486,463 | 870,468 | 1.79 | 1,028 | 604,543 | 776,896 | 995,717 |
| North Carolina and Georgia | 2 | 1 | 226,156 | 339,382 | 1.50 | 733 | 265,464 | 426,065 | 724,500 |
| North Dakota | 5 | 337 | 28,907 | 41,431 | 1.43 | 76 | 18.460 | 21,740 | 66,580 |
| Ohio | 323 | 1,745 | 9,976,787 | 9,355,400 | 0.94 | 19,591 | 6,892,604 | 8,232,183 | 14,018,236 |
| Pennsylvania | 525 | 2,949 | 36,174,089 | 27,953,315 | 0.77 | 53,712 | 20,738,647 | 25,977,106 | 53,322,330 |
| Tennessee | 39 | 43 | 1,925,689 | 2,338,309 | 1.21 | 4.108 | 1,609,310 | 2,113,292 | 4,362,711 |
| Texas | 4 | 6 | 128,216 | 340,620 | 2.66 | 549 | 256,834 | 324,157 | 307,335 |
| Utah | 4 | 7 | 236,651 | 377,456 | 1.59 | 565 | 268,570 | 342,796 | 844,560 |
| Virginia | 11 | 47 | 865,786 | 804,475 | 0.93 | 1,555 | 621,266 | 682,408 | 1,055,516 |
| Washington | 12 | ....... | 1,030,578 | 2,393,238 | 2.32 | 2,695 | 1,747,080 | 2,254,486 | 3,186,441 |
| West Virginia | 115 | 996 | 6,231,880 | 5,086,584 | 0.82 | 9,952 | 3,888,712 | 4,841,796 | 10,508,050 |
| Wyoming | 15 | 10 | 1,388,947 | 1,748,617 | 1.26 | 2,692 | 1,553,947 | 1,823,956 | 2,239,252 |
| Total bituminous | 2,218 | 9,920 | 95,629,026 | 94,346,809 | 0.99 | 175,242 | 69,765,711 | 85,324,193 | 180,722,319 |
| Anthracite: |  |  |  |  |  |  |  |  |  |
| Pennsylvania | 362 | 49 | 45,544,970 | *b*65,721,578 | *b*1.58 | 124,203 | 39,278,355 | 61,109,958 | 161,784,473 |
| Colorado, New Mexico, and Rhode Island | 3 | ....... | 55,517 | 157,936 | 2.84 | 107 | 86,862 | 102,129 | 251,137 |
| Total anthracite | 365 | 49 | 45,600,487 | *b*65,879,514 | *b*1.58 | 124,310 | 39,365,217 | 61,212,087 | 162,035,610 |

*a* Local mines are not considered in the tables relating to labor, expenditures, and the value of lands and improvements.

*b* Not including value of anthracite used for steam at the mines.

## COAL PRODUCT OF THE UNITED STATES IN 1889, BY STATES AND TERRITORIES.

[Short tons.]

| STATES AND TERRITORIES. | Total product of coal of all grades for year 1889. | DISPOSITION OF TOTAL PRODUCT. Loaded at mines for shipment on railroad cars and boats. | DISPOSITION OF TOTAL PRODUCT. Sold to local trade at mines. | DISPOSITION OF TOTAL PRODUCT. Used by employés. | DISPOSITION OF TOTAL PRODUCT. Used for steam at mines. | DISPOSITION OF TOTAL PRODUCT. Manufactured into coke. | Total amount received for coal sold in 1889. |
|---|---|---|---|---|---|---|---|
| Grand total | 141, 229, 513 | 113, 776, 701 | 7, 582, 536 | 926, 163 | 5, 382, 265 | 13, 561, 848 | *a*$160, 226, 323 |
| Bituminous: | | | | | | | |
| Alabama | 3, 572, 983 | 2, 327, 209 | 38, 835 | 21, 110 | 79, 515 | 1, 106, 314 | 3, 961, 491 |
| Arkansas | 279, 584 | 268, 518 | 5, 020 | 1, 800 | 4, 246 | | 395, 836 |
| California and Oregon | 184, 179 | 173, 611 | 3, 854 | 608 | 6, 106 | | 434, 382 |
| Colorado | 2, 544, 144 | 2, 059, 848 | 70, 595 | 18, 453 | 87, 187 | 308, 061 | 3, 843, 992 |
| Georgia and North Carolina | 226, 156 | 46, 321 | 31 | 158 | 15, 001 | 164, 645 | 339, 382 |
| Illinois | 12, 104, 272 | 9, 884, 883 | 1, 699, 478 | 111, 224 | 395, 787 | 12, 900 | 11, 755, 203 |
| Indiana | 2, 845, 057 | 2, 527, 112 | 217, 041 | 20, 894 | 67, 210 | 12, 800 | 2, 887, 852 |
| Indian territory | 752, 832 | 699, 122 | 1, 173 | 5, 922 | 33, 997 | 12, 618 | 1, 323, 807 |
| Iowa | 4, 095, 358 | 3, 530, 373 | 420, 596 | 44, 139 | 100, 213 | 37 | 5, 426, 509 |
| Kansas and Nebraska | 2, 222, 443 | 1, 891, 090 | 267, 047 | 34, 560 | 29, 246 | 500 | 3, 301, 788 |
| Kentucky | 2, 399, 755 | 2, 111, 010 | 225, 234 | 21, 072 | 23, 981 | 18, 458 | 2, 374, 339 |
| Maryland | 2, 939, 715 | 2, 885, 336 | 37, 667 | 6, 550 | 10, 162 | | 2, 517, 474 |
| Michigan | 67, 431 | 53, 104 | 8, 289 | 821 | 5, 217 | | 115, 011 |
| Missouri | 2, 557, 823 | 2, 246, 845 | 259, 587 | 16, 412 | 34, 979 | | 3, 479, 057 |
| Montana | 363, 301 | 314, 372 | 10, 755 | 2, 162 | 5, 436 | 30, 576 | 880, 773 |
| New Mexico | 486, 463 | 466, 127 | 5, 371 | 2, 582 | 6, 383 | 6, 000 | 870, 468 |
| North Dakota | 28, 907 | 18, 610 | 9, 792 | 505 | | | 41, 431 |
| Ohio | 9, 976, 787 | 8, 566, 223 | 1, 196, 872 | 50, 271 | 93, 952 | 69, 469 | 9, 355, 400 |
| Pennsylvania | 36, 174, 089 | 24, 059, 913 | 1, 432, 361 | 158, 290 | 332, 937 | 10, 190, 588 | 27, 953, 315 |
| Tennessee | 1, 925, 689 | 1, 334, 424 | 13, 212 | 15, 889 | 23, 034 | 539, 130 | 2, 338, 309 |
| Texas | 128, 216 | 120, 602 | 6, 348 | 204 | 1, 062 | | 340, 620 |
| Utah | 236, 651 | 216, 960 | 15, 050 | 2, 012 | 412 | 2, 217 | 377, 456 |
| Virginia | 865, 786 | 732, 881 | 7, 546 | 5, 633 | 7, 516 | 112, 210 | 804, 475 |
| Washington | 1, 030, 578 | 956, 046 | 11, 036 | 4, 538 | 19, 958 | 39, 000 | 2, 393, 238 |
| West Virginia | 6, 231, 880 | 4, 764, 900 | 448, 527 | 44, 760 | 37, 368 | 936, 325 | 5, 086, 584 |
| Wyoming | 1, 388, 947 | 1, 354, 443 | 7, 330 | 8, 103 | 19, 071 | | 1, 748, 617 |
| Total bituminous | 95, 629, 026 | 73, 609, 883 | 6, 418, 647 | 598, 672 | 1, 439, 976 | 13, 561, 848 | 94, 346, 809 |
| Anthracite: | | | | | | | |
| Pennsylvania | 45, 544, 970 | 40, 114, 901 | 1, 163, 539 | 325, 591 | 3, 940, 939 | | *a*65, 721, 578 |
| Colorado and New Mexico | 53, 517 | 49, 917 | 350 | 1, 900 | 1, 350 | | 151, 936 |
| Rhode Island | 2, 000 | 2, 000 | | | | | 6, 000 |
| Total anthracite | 45, 600, 487 | 40, 166, 818 | 1, 163, 889 | 327, 491 | 3, 942, 289 | | *a*65, 879, 514 |

*a* Not including value of anthracite used for steam at the mines.

## LABOR AND WAGES AT COAL MINES OF THE UNITED STATES IN 1889, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | Total employés about mine. | ABOVE GROUND. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total average number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Total | 296, 623 | 67, 137 | 2, 285 | ........ | ........ | 8, 603 | ........ | ........ | 38, 413 | ........ | ........ | 17, 836 | ........ | ........ |
| Alabama | 6, 864 | 1, 018 | 57 | $2. 52 | 276 | 123 | $2. 12 | 231 | 797 | $1. 25 | 218 | 41 | $0. 62 | 212 |
| Arkansas | 677 | 116 | 5 | 2. 69 | 248 | 21 | 2. 22 | 208 | 79 | 1. 49 | 210 | 11 | 0. 70 | 159 |
| California and Oregon. | 413 | 76 | 6 | 5. 12 | 296 | 20 | 2. 90 | 236 | 48 | 2. 04 | 248 | 2 | 1. 50 | 240 |
| Colorado | 4, 904 | 807 | 53 | 3. 50 | 278 | 161 | 2. 98 | 229 | 571 | 2. 21 | 234 | 22 | 1. 25 | 221 |
| Georgia and North Carolina. | 733 | 329 | 12 | 2. 29 | 264 | 34 | 2. 15 | 210 | 277 | 0. 96 | 255 | 6 | 0. 45 | 24 |
| Illinois | 23, 934 | 2, 584 | 217 | 2. 33 | 262 | 625 | 2. 02 | 266 | 1, 678 | 1. 52 | 201 | 64 | 0. 80 | 200 |
| Indiana | 6, 448 | 666 | 74 | 2. 36 | 255 | 160 | 1. 84 | 256 | 426 | 1. 47 | 192 | 6 | 0. 71 | 152 |
| Indian territory | 1, 862 | 220 | 11 | 2. 55 | 291 | 63 | 2. 50 | 170 | 145 | 1. 90 | 164 | 1 | 1. 00 | 250 |
| Iowa | 9, 247 | 1, 075 | 147 | 2. 20 | 228 | 202 | 2. 21 | 253 | 709 | 1. 57 | 209 | 17 | 0. 78 | 169 |
| Kansas and Nebraska. | 5, 956 | 742 | 69 | 2. 37 | 190 | 160 | 2. 23 | 200 | 488 | 1. 55 | 197 | 25 | 0. 79 | 156 |
| Kentucky | 5, 144 | 893 | 76 | 2. 44 | 270 | 152 | 1. 81 | 242 | 627 | 1. 30 | 204 | 38 | 0. 75 | 205 |
| Maryland | 3, 702 | 321 | 15 | 3. 04 | 266 | 65 | 2. 03 | 264 | 225 | 1. 59 | 196 | 16 | 0. 90 | 187 |
| Michigan | 261 | 46 | 7 | 2. 10 | 199 | 11 | 1. 91 | 213 | 28 | 1. 92 | 249 | ........ | ........ | ........ |
| Missouri | 6, 631 | 950 | 122 | 2. 09 | 228 | 107 | 2. 11 | 246 | 692 | 1. 52 | 214 | 29 | 0. 80 | 181 |
| Montana | 848 | 171 | 9 | 5. 28 | 251 | 38 | 3. 58 | 252 | 123 | 2. 50 | 240 | 1 | 2. 00 | 300 |
| New Mexico | 1, 015 | 157 | 13 | 3. 27 | 208 | 26 | 2. 88 | 231 | 112 | 2. 37 | 214 | 6 | 1. 07 | 187 |
| North Dakota | 75 | 13 | 7 | 2. 29 | 115 | 3 | 2. 67 | 88 | 3 | 1. 50 | 100 | ........ | ........ | ........ |
| Ohio | 19, 343 | 2, 058 | 221 | 2. 28 | 244 | 334 | 1. 91 | 235 | 1, 420 | 1. 51 | 192 | 83 | 0. 77 | 187 |
| Pennsylvania (anthracite). | 123, 676 | 46, 154 | 564 | 2. 71 | 291 | 4, 720 | 1. 91 | 257 | 23, 779 | 1. 29 | 198 | 17, 091 | 0. 62 | 185 |
| Pennsylvania (bituminous). | 53, 132 | 4, 979 | 378 | 2. 57 | 250 | 1, 028 | 2. 13 | 237 | 3, 366 | 1. 67 | 208 | 207 | 0. 83 | 200 |
| Tennessee | 4, 031 | 569 | 48 | 2. 47 | 249 | 101 | 1. 86 | 244 | 393 | 1. 21 | 222 | 27 | 0. 55 | 190 |
| Texas | 543 | 121 | 7 | 2. 91 | 283 | 5 | 2. 50 | 260 | 109 | 1. 52 | 248 | ........ | ........ | ........ |
| Utah | 551 | 84 | 3 | 3. 63 | 246 | 18 | 2. 84 | 238 | 59 | 2. 35 | 198 | 4 | 0. 97 | 252 |
| Virginia | 1, 523 | 521 | 16 | 1. 99 | 245 | 51 | 2. 04 | 269 | 407 | 1. 16 | 282 | 47 | 0. 51 | 210 |
| Washington | 2, 657 | 540 | 21 | 3. 76 | 293 | 94 | 3. 04 | 255 | 396 | 2. 29 | 242 | 29 | 1. 41 | 214 |
| West Virginia | 9, 778 | 1, 558 | 117 | 2. 48 | 270 | 244 | 1. 90 | 246 | 1, 135 | 1. 36 | 211 | 62 | 0. 76 | 203 |
| Wyoming | 2, 675 | 369 | 10 | 4. 42 | 263 | 37 | 2. 98 | 269 | 321 | 2. 21 | 253 | 1 | 1. 50 | 156 |

LABOR AND WAGES AT COAL MINES OF THE UNITED STATES IN 1889, BY STATES AND TERRITORIES—Continued.

| STATES AND TERRITORIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total average number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Total | 229, 486 | 2, 859 | .......... | .......... | 158, 060 | .......... | .......... | 58, 771 | .......... | .......... | 9, 796 | .......... | .......... | $106, 937, 058 |
| Alabama | 5, 846 | 73 | $2. 74 | 272 | 4, 110 | $2. 15 | 248 | 1, 564 | $1. 33 | 237 | 99 | $0. 66 | 224 | 3, 157, 109 |
| Arkansas | 561 | 10 | 2. 71 | 228 | 462 | 2. 20 | 180 | 64 | 2. 00 | 186 | 25 | 0. 71 | 199 | 248, 899 |
| California and Oregon. | 337 | 9 | 3. 17 | 271 | 235 | 2. 58 | 224 | 85 | 2. 32 | 268 | 8 | 1. 47 | 239 | 241, 249 |
| Colorado | 4, 097 | 46 | 3. 36 | 287 | 3, 390 | 2. 65 | 212 | 564 | 2. 65 | 214 | 97 | 1. 18 | 220 | 2, 734, 895 |
| Georgia and North Carolina. | 404 | 13 | 1. 64 | 210 | 271 | 1. 46 | 291 | 120 | 0. 98 | 288 | .......... | .......... | .......... | 258, 016 |
| Illinois | 21, 350 | 305 | 2. 38 | 256 | 15, 386 | 1. 95 | 177 | 5, 062 | 1. 76 | 199 | 597 | 0. 89 | 176 | 8, 429, 553 |
| Indiana | 5, 782 | 135 | 2. 37 | 170 | 4, 738 | 1. 89 | 175 | 820 | 1. 70 | 182 | 89 | 0. 72 | 184 | 2, 144, 566 |
| Indian territory | 1, 642 | 10 | 3. 10 | 252 | 1, 200 | 3. 25 | 166 | 393 | 2. 41 | 177 | 39 | 0. 88 | 198 | 915, 567 |
| Iowa | 8, 172 | 139 | 2. 46 | 251 | 6, 588 | 2. 23 | 196 | 1, 191 | 1. 89 | 217 | 254 | 0. 77 | 200 | 3, 860, 893 |
| Kansas and Nebraska. | 5, 214 | 103 | 2. 46 | 230 | 4, 447 | 1. 89 | 207 | 456 | 1. 75 | 222 | 208 | 0. 88 | 219 | 2, 258, 485 |
| Kentucky | 4, 251 | 59 | 2. 33 | 255 | 3, 406 | 1. 75 | 193 | 674 | 1. 56 | 219 | 112 | 0. 70 | 213 | 1, 669, 524 |
| Maryland | 3, 381 | 22 | 3. 04 | 289 | 2, 689 | 2. 45 | 203 | 386 | 1. 86 | 222 | 284 | 1. 06 | 200 | 1, 700, 305 |
| Michigan | 215 | 4 | 2. 34 | 218 | 191 | 1. 74 | 184 | 10 | 1. 69 | 216 | 10 | 0. 87 | 300 | 90, 124 |
| Missouri | 5, 681 | 103 | 2. 34 | 230 | 4, 780 | 2. 04 | 201 | 656 | 1. 72 | 206 | 142 | 0. 71 | 203 | 2, 476, 870 |
| Montana | 677 | 11 | 4. 31 | 248 | 521 | 3. 19 | 213 | 143 | 2. 60 | 235 | 2 | 1. 50 | 300 | 576, 773 |
| New Mexico | 858 | 9 | 3. 58 | 287 | 688 | 3. 08 | 192 | 146 | 2. 59 | 207 | 15 | 1. 09 | 185 | 584, 376 |
| North Dakota | 62 | 3 | 3. 00 | 117 | 55 | 2. 15 | 108 | 4 | 1. 88 | 111 | .......... | .......... | .......... | 17, 560 |
| Ohio | 17, 285 | 221 | 2. 32 | 245 | 14, 733 | 1. 95 | 181 | 1, 955 | 1. 63 | 185 | 376 | 0. 71 | 181 | 6, 730, 778 |
| Pennsylvania (anthracite). | 77, 522 | 737 | 3. 05 | 291 | 36, 639 | 2. 39 | 179 | 35, 376 | 1. 64 | 184 | 4, 770 | 0. 88 | 180 | 38, 867, 331 |
| Pennsylvania (bituminous). | 48, 153 | 606 | 2. 57 | 256 | 40, 100 | 1. 93 | 210 | 5, 303 | 1. 84 | 220 | 2, 144 | 0. 78 | 217 | 20, 327, 805 |
| Tennessee | 3, 462 | 55 | 2. 14 | 245 | 2, 538 | 1. 98 | 227 | 696 | 1. 26 | 228 | 173 | 0. 72 | 229 | 1, 548, 392 |
| Texas | 422 | 6 | 2. 65 | 248 | 340 | 2. 00 | 264 | 56 | 1. 77 | 236 | 20 | 0. 75 | 40 | 252, 470 |
| Utah | 467 | 5 | 3. 47 | 260 | 332 | 3. 21 | 163 | 101 | 2. 51 | 169 | 29 | 1. 00 | 168 | 258, 601 |
| Virginia | 1, 002 | 12 | 2. 44 | 265 | 712 | 1. 53 | 285 | 253 | 1. 59 | 269 | 25 | 1. 14 | 274 | 604, 796 |
| Washington | 2, 117 | 31 | 3. 97 | 286 | 1, 549 | 3. 26 | 197 | 509 | 2. 46 | 222 | 28 | 1. 06 | 222 | 1, 696, 293 |
| West Virginia | 8, 220 | 118 | 2. 46 | 269 | 6, 367 | 1. 86 | 223 | 1, 504 | 1. 47 | 224 | 231 | 0. 66 | 220 | 3, 748, 721 |
| Wyoming | 2, 306 | 14 | 3. 31 | 310 | 1, 593 | 2. 71 | 231 | 680 | 2. 47 | 220 | 19 | 1. 32 | 238 | 1, 537, 107 |

## TOTAL EXPENDITURES AT COAL MINES IN 1889, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| Grand total | 2, 936 | $2, 193, 870 | 2, 846 | $2, 163, 775 | 90 | $30, 095 | 299, 559 | $109, 130, 928 | $18, 828, 590 | $15, 421, 591 | $143, 381, 109 | $3, 155, 171 | $146, 536, 280 |
| **Bituminous:** | | | | | | | | | | | | | |
| Alabama | 111 | 110, 748 | 110 | 110, 388 | 1 | 360 | 6, 975 | 3, 267, 857 | 261, 512 | 161, 046 | 3, 690, 415 | 36, 524 | 3, 726, 939 |
| Arkansas | 9 | 3, 780 | 9 | 3, 780 | ...... | ......... | 686 | 252, 679 | 39, 158 | 16, 874 | 308, 711 | ............ | 308, 711 |
| California and Oregon. | 6 | 7, 200 | 6 | 7, 200 | ...... | ......... | 419 | 248, 449 | 56, 678 | 43, 590 | 348, 717 | 16, 225 | 364, 942 |
| Colorado | 68 | 75, 022 | 65 | 73, 847 | 3 | 1, 175 | 4, 872 | 2, 724, 800 | 490, 152 | 388, 657 | 3, 603, 609 | 91, 689 | 3, 695, 298 |
| Georgia and North Carolina. | 7 | 7, 448 | 6 | 7, 165 | 1 | 283 | 740 | 265, 464 | 102, 655 | 6, 546 | 374, 665 | 51, 400 | 426, 065 |
| Illinois | 389 | 264, 794 | 374 | 260, 104 | 15 | 4, 690 | 24, 323 | 8, 694, 347 | 966, 927 | 678, 133 | 10, 339, 407 | 26, 662 | 10, 366, 069 |
| Indiana | 84 | 56, 478 | 77 | 54, 038 | 7 | 2, 440 | 6, 532 | 2, 201, 044 | 241, 094 | 133, 724 | 2, 575, 862 | 5, 807 | 2, 581, 669 |
| Indian territory. | 11 | 11, 700 | 11 | 11, 700 | ...... | ......... | 1, 873 | 927, 267 | 53, 404 | 172, 150 | 1, 152, 821 | 20, 000 | 1, 172, 821 |
| Iowa | 137 | 95, 895 | 130 | 93, 131 | 7 | 2, 764 | 9, 384 | 3, 956, 788 | 357, 033 | 353, 935 | 4, 667, 756 | 65, 194 | 4, 732, 950 |
| Kansas and Nebraska. | 113 | 62, 103 | 99 | 60, 469 | 14 | 1, 634 | 6, 069 | 2, 320, 588 | 262, 820 | 141, 044 | 2, 724, 452 | 6, 330 | 2, 730, 782 |
| Kentucky | 116 | 86, 839 | 111 | 84, 639 | 5 | 2, 200 | 5, 260 | 1, 756, 363 | 237, 321 | 117, 765 | 2, 111, 449 | 45, 099 | 2, 156, 548 |
| Maryland | 39 | 30, 382 | 39 | 30, 382 | ...... | ......... | 3, 741 | 1, 730, 687 | 203, 155 | 121, 453 | 2, 055, 295 | 5, 763 | 2, 061, 058 |
| Michigan | 4 | 3, 470 | 4 | 3, 470 | ...... | ......... | 265 | 93, 594 | 9, 085 | 11, 035 | 113, 714 | ............ | 113, 714 |
| Missouri | 99 | 61, 403 | 97 | 60, 964 | 2 | 439 | 6, 730 | 2 538, 273 | 181, 218 | 107, 867 | 2, 827, 358 | 18, 779 | 2, 846, 137 |
| Montana | 9 | 10, 765 | 9 | 10, 765 | ...... | ......... | 857 | 587, 538 | 52, 098 | 7, 038 | 646, 674 | 3, 000 | 649, 674 |
| New Mexico | 19 | 20, 892 | 19 | 20, 892 | ...... | ......... | 1, 028 | 604, 543 | 102, 600 | 62, 593 | 769, 736 | 7, 160 | 776, 896 |
| North Dakota | 1 | 900 | 1 | 900 | ...... | ......... | 76 | 18, 460 | 2, 900 | 380 | 21, 740 | ............ | 21, 740 |
| Ohio | 248 | 161, 826 | 240 | 159, 072 | 8 | 2, 754 | 19, 591 | 6, 892, 604 | 568, 020 | 712, 792 | 8, 173, 416 | 58, 767 | 8, 232, 183 |
| Pennsylvania | 580 | 410, 842 | 566 | 404, 312 | 14 | 6, 530 | 53, 712 | 20, 738, 647 | 2, 393, 386 | 2, 562, 851 | 25, 694, 884 | 282, 222 | 25, 977, 106 |
| Tennessee | 77 | 60, 918 | 74 | 59, 328 | 3 | 1, 590 | 4, 108 | 1, 609, 310 | 271, 390 | 219, 268 | 2, 099, 968 | 13, 324 | 2, 113, 292 |
| Texas | 6 | 4, 364 | 6 | 4, 364 | ...... | ......... | 549 | 256, 834 | 54, 333 | 12, 990 | 324, 157 | ............ | 324, 157 |
| Utah | 14 | 9, 969 | 12 | 9, 834 | 2 | 135 | 565 | 268, 570 | 65, 911 | 5, 417 | 339, 898 | 2, 898 | 342, 796 |
| Virginia | 32 | 16, 470 | 27 | 14, 370 | 5 | 2, 100 | 1, 555 | 621, 266 | 46, 754 | 13, 456 | 681, 476 | 932 | 682, 408 |
| Washington | 38 | 50, 787 | 37 | 50, 487 | 1 | 300 | 2, 695 | 1, 747, 080 | 287, 211 | 210, 899 | 2, 245, 190 | 9, 296 | 2, 254, 486 |
| West Virginia | 174 | 139, 991 | 173 | 139, 540 | 1 | 451 | 9, 952 | 3, 888, 712 | 462, 591 | 443, 394 | 4, 794, 697 | 47, 099 | 4, 841, 796 |
| Wyoming | 17 | 16, 840 | 17 | 16, 840 | ...... | ......... | 2, 692 | 1, 553, 947 | 224, 804 | 37, 324 | 1, 816, 075 | 7, 881 | 1, 823, 956 |
| **Total bituminous** | 2, 408 | 1, 781, 826 | 2, 319 | 1, 751, 981 | 89 | 29, 845 | 175, 249 | 69, 765, 711 | 7, 994, 210 | 6, 742, 221 | 84, 502, 142 | 822, 051 | 85, 324, 193 |
| **Anthracite:** | | | | | | | | | | | | | |
| Pennsylvania | 527 | 411, 024 | 526 | 410, 774 | 1 | 250 | 124, 203 | 39, 278, 355 | 10, 822, 363 | 8, 676, 320 | 58, 777, 038 | 2, 332, 920 | 61, 109, 958 |
| Colorado, New Mexico, and Rhode Island. | 1 | 1, 020 | 1 | 1, 020 | ...... | ......... | 107 | 86, 862 | 12, 017 | 3, 050 | 101, 929 | 200 | 102, 129 |
| **Total anthracite** | 528 | 412, 044 | 527 | 411, 794 | 1 | 250 | 124, 310 | 39, 365, 217 | 10, 834, 380 | 8, 679, 370 | 58, 878, 967 | 2, 333, 120 | 61, 212, 087 |

VALUE OF LANDS AND IMPROVEMENTS AT COAL MINES IN THE UNITED STATES IN 1889, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | | | Number of animals employed. |
|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | |
| | Acres. | Value. | Acres. | Value. | | | | | | |
| Grand total | 1, 248, 373 | $134, 854, 793 | 493, 118 | $91, 830, 253 | $64, 065, 329 | $35, 086, 081 | $325, 836, 456 | $16, 921, 473 | $342, 757, 929 | 30, 272 |
| **Bituminous:** | | | | | | | | | | |
| Alabama | 216, 129 | 9, 476, 341 | 6, 620 | 161, 600 | 1, 231, 228 | 1, 248, 159 | 12, 117, 328 | 417, 866 | 12, 535, 194 | 532 |
| Arkansas | 15, 969 | 1, 041, 876 | 1, 095 | 55, 750 | 77, 098 | 77, 777 | 1, 252, 501 | 37, 250 | 1, 289, 751 | 75 |
| California and Oregon | 4, 012 | 238, 400 | ........ | ........ | 157, 500 | 94, 400 | 490, 300 | 36, 450 | 526, 750 | 57 |
| Colorado | 53, 529 | 4, 757, 090 | 20, 260 | 5, 053, 820 | 1, 236, 603 | 1, 183, 772 | 12, 231, 285 | 380, 564 | 12, 611, 849 | 592 |
| Georgia and North Carolina | 20, 733 | 348, 300 | ........ | ........ | 58, 000 | 283, 000 | 689, 300 | 35, 200 | 724, 500 | 49 |
| Illinois | 161, 468 | 8, 074, 020 | 30, 272 | 1, 816, 644 | 3, 923, 747 | 2, 325, 547 | 16, 139, 958 | 1, 490, 393 | 17, 630, 351 | 2, 230 |
| Indiana | 15, 785 | 1, 213, 445 | 9, 023 | 576, 050 | 553, 449 | 719, 463 | 3, 062, 407 | 373, 296 | 3, 435, 703 | 719 |
| Indian territory | ........ | ........ | 14, 766 | 738, 643 | 497, 509 | 131, 067 | 1, 367, 219 | 124, 790 | 1, 492, 009 | 169 |
| Iowa | 24, 239 | 2, 178, 832 | 14, 443 | 945, 749 | 1, 210, 421 | 1, 330, 927 | 5, 665, 929 | 613, 250 | 6, 279, 179 | 929 |
| Kansas and Nebraska | 36, 077 | 1, 588, 974 | 3, 939 | 285, 760 | 629, 438 | 652, 416 | 3, 156, 588 | 331, 951 | 3, 488, 539 | 605 |
| Kentucky | 106, 622 | 2, 827, 755 | 21, 478 | 1, 050, 240 | 1, 364, 523 | 1, 007, 951 | 6, 250, 469 | 330, 911 | 6, 581, 380 | 723 |
| Maryland | 48, 100 | 15, 707, 629 | 2, 420 | 176, 000 | 1, 521, 655 | 392, 193 | 17, 797, 477 | 227, 890 | 18, 025, 367 | 310 |
| Michigan | 142 | 7, 800 | 480 | 9, 600 | 7, 800 | 12, 750 | 37, 950 | 11, 700 | 49, 650 | 22 |
| Missouri | 24, 276 | 1, 732, 197 | 11, 641 | 685, 772 | 527, 654 | 716, 105 | 3, 661, 728 | 330, 565 | 3, 992, 293 | 542 |
| Montana | 9, 110 | 628, 903 | 400 | 125, 000 | 76, 033 | 251, 640 | 1, 081, 576 | 71, 500 | 1, 153, 076 | 69 |
| New Mexico | 10, 480 | 361, 543 | 800 | 13, 540 | 293, 393 | 242, 921 | 911, 397 | 84, 320 | 995, 717 | 144 |
| North Dakota | 520 | 51, 700 | ........ | ........ | 5, 980 | 3, 820 | 61, 500 | 5, 080 | 66, 580 | 15 |
| Ohio | 66, 697 | 6, 329, 766 | 38, 201 | 2, 697, 874 | 2, 270, 971 | 1, 730, 656 | 13, 029, 267 | 988, 969 | 14, 018, 236 | 2, 127 |
| Pennsylvania | 132, 811 | 21, 817, 269 | 98, 025 | 16, 281, 741 | 7, 118, 900 | 5, 020, 101 | 50, 238, 011 | 3, 084, 319 | 53, 322, 330 | 5, 383 |
| Tennessee | 78, 289 | 1, 363, 500 | 55, 623 | 1, 094, 350 | 1, 046, 454 | 638, 095 | 4, 142, 399 | 220, 312 | 4, 362, 711 | 611 |
| Texas | 1, 000 | 10, 000 | 3, 780 | 105, 000 | 68, 199 | 90, 136 | 273, 335 | 34, 000 | 307, 335 | 51 |
| Utah | 5, 910 | 509, 926 | ........ | ........ | 171, 637 | 107, 397 | 788, 960 | 55, 600 | 844, 560 | 57 |
| Virginia | 13, 900 | 290, 100 | 3, 790 | 103, 600 | 363, 270 | 273, 168 | 1, 030, 138 | 25, 378 | 1, 055, 516 | 109 |
| Washington | 20, 322 | 1, 724, 000 | 2, 876 | 95, 760 | 326, 984 | 746, 903 | 2, 893, 647 | 292, 794 | 3, 186, 441 | 193 |
| West Virginia | 61, 531 | 3, 694, 987 | 45, 990 | 2, 806, 280 | 2, 160, 249 | 1, 255, 965 | 9, 917, 481 | 590, 569 | 10, 508, 050 | 1, 305 |
| Wyoming | 13, 360 | 1, 252, 518 | ........ | ........ | 403, 236 | 392, 198 | 2, 047, 952 | 191, 300 | 2, 239, 252 | 161 |
| Total bituminous | 1, 141, 011 | 87, 226, 871 | 385, 922 | 34, 878, 773 | 27, 301, 931 | 20, 928, 527 | 170, 336, 102 | 10, 386, 217 | 180, 722, 319 | 17, 779 |
| **Anthracite:** | | | | | | | | | | |
| Pennsylvania | 107, 282 | 47, 626, 322 | 106, 656 | 56, 789, 480 | 36, 733, 648 | 14, 110, 617 | 155, 260, 067 | 6, 524, 406 | 161, 784, 473 | 12, 463 |
| Colorado, New Mexico, and Rhode Island. | 80 | 1, 600 | 540 | 162, 000 | 29, 750 | 46, 937 | 240, 287 | 10, 850 | 251, 137 | 30 |
| Total anthracite | 107, 362 | 47, 627, 922 | 107, 196 | 56, 951, 480 | 36, 763, 398 | 14, 157, 554 | 155, 500, 354 | 6, 535, 256 | 162, 035, 610 | 12, 493 |

## DISTRIBUTION.

The statistics of the distribution of coal in the United States, as shown in the tables following, have been collected with great difficulty. Details have been obtained mainly from transportation companies. Owing to the diverse methods of keeping station accounts of freights received and delivered, as well as accounts of interchange at junction points (many roads making no distinction between anthracite and bituminous coal), the necessary data as to coal delivered for consumption at the different points has been in some cases necessarily approximated. Such estimates, however, have usually been made by some one familiar with the facts applying to his particular district, and are accepted as substantially correct. These tables are presented, therefore, not so much as exhibiting absolute accuracy, as of showing by the best data obtainable the practical facts upon the subject.

## PRODUCTION AND DISTRIBUTION OF COAL FOR THE YEAR 1889.

[Short tons.]

| STATES AND TERRITORIES. | Population 1890. | PRODUCTION. |  | CONSUMPTION. |  |
|---|---|---|---|---|---|
|  |  | Bituminous. | Anthracite. | Bituminous. | Anthracite. |
| Grand total |  | 95, 629, 026 | 45, 600, 487 | 95, 831, 215 | 45, 618, 663 |
| Alabama | 1, 513, 017 | 3, 572, 983 |  | 1, 925, 689 | 1, 079 |
| Arizona | 59, 620 |  |  | 41, 686 |  |
| Arkansas | 1, 128, 179 | 279, 584 |  | 355, 819 | 526 |
| California | 1, 208, 130 | 119, 820 |  | 1, 301, 989 | 37, 477 |
| Colorado | 412, 198 | 2, 544, 144 | 53, 517 | 1, 876, 291 | 52, 060 |
| Connecticut | 746, 258 |  |  | 935, 533 | 964, 967 |
| Delaware | 168, 493 |  |  | 307, 019 | 230, 421 |
| District of Columbia | 230, 392 |  |  | 45, 050 | 481, 088 |
| Florida | 391, 422 |  |  | 19, 652 | 12, 145 |
| Georgia | 1, 837, 353 | 226, 156 |  | 869, 727 | 34, 055 |
| North Carolina | 1, 617, 947 |  |  | 191, 142 | 30, 078 |
| Idaho | 84, 385 |  |  | 273, 211 |  |
| Illinois | 3, 826, 351 | 12, 104, 272 |  | 11, 004, 980 | 1, 980, 180 |
| Indiana | 2, 192, 404 | 2, 845, 057 |  | 3, 299, 354 | 208, 550 |
| Indian territory |  | 752, 832 |  | 104, 827 |  |
| Iowa | 1, 911, 896 | 4, 095, 358 |  | 3, 411, 044 | 235, 774 |
| Kansas | 1, 427, 096 | 2, 222, 443 |  | 2, 250, 357 | 115, 597 |
| Nebraska | 1, 058, 910 |  |  | 1, 757, 662 | 110, 892 |
| Kentucky | 1, 858, 635 | 2, 399, 755 |  | 2, 196, 330 | 4, 692 |
| Louisiana | 1, 118, 587 |  |  | 619, 294 | 12, 107 |
| Maine | 661, 086 |  |  | 318, 754 | 580, 232 |
| Maryland | 1, 042, 390 | 2, 939, 715 |  | 1, 383, 857 | 622, 883 |
| Massachusetts | 2, 238, 943 |  |  | 3, 121, 927 | 3, 274, 133 |
| Michigan | 2, 093, 889 | 67, 431 |  | 1, 635, 472 | 558, 243 |
| Minnesota | 1, 301, 826 |  |  | 1, 883, 599 | 477, 009 |
| Mississippi | 1, 289, 600 |  |  | 524, 318 | 947 |
| Missouri | 2, 679, 184 | 2, 557, 823 |  | 3, 122, 283 | 56, 245 |
| Montana | 132, 159 | 363, 301 |  | 776, 266 | 7, 263 |
| Nevada | 45, 761 |  |  | 99, 044 | 535 |
| New Hampshire | 376, 530 |  |  | 352, 244 | 334, 569 |
| New Jersey | 1, 444, 933 |  |  | 1, 498, 200 | 3, 959, 195 |
| New Mexico | 153, 593 | 486, 463 |  | 164, 912 |  |
| New York | 5, 997, 853 |  |  | 5, 665, 432 | 10, 985, 498 |
| North Dakota | 182, 719 | 28, 907 |  | 420, 842 | 48, 361 |
| South Dakota | 328, 808 |  |  |  |  |
| Ohio | 3, 672, 316 | 9, 976, 787 |  | 9, 601, 216 | 596, 162 |
| Oregon | 313, 767 | 64, 359 |  | 97, 063 | 6, 000 |
| Pennsylvania | 5, 258, 014 | 36, 174, 089 | 45, 544, 970 | 7, 489, 113 | 16, 156, 795 |
| Rhode Island | 345, 506 |  | 2, 000 | 505, 017 | 533, 498 |
| South Carolina | 1, 151, 149 |  |  | 130, 319 | 47, 261 |
| Tennessee | 1, 767, 518 | 1, 925, 689 |  | 1, 561, 366 | 1, 542 |
| Texas | 2, 235, 523 | 128, 216 |  | 1, 653, 847 | 11, 979 |
| Utah | 207, 905 | 236, 651 |  | 403, 466 | 5, 125 |
| Vermont | 332, 422 |  |  | 185, 188 | 373, 891 |
| Virginia | 1, 655, 980 | 865, 786 |  | 1, 070, 370 | 252, 457 |
| Washington | 349, 390 | 1, 030, 578 |  | 556, 037 | 4, 000 |
| West Virginia | 762, 794 | 6, 231, 880 |  | 952, 388 | 7, 043 |
| Wisconsin | 1, 686, 880 |  |  | 2, 054, 906 | 940, 502 |
| Wyoming | 60, 705 | 1, 388, 947 |  | 562, 403 | 90 |
| Total |  | 95, 629, 026 | 45, 600, 487 | 80, 576, 505 | 44, 353, 146 |
| Exported to Canada |  |  |  | 1, 319, 398 | 1, 226, 104 |
| Exported to other countries |  |  |  | 373, 464 | 39, 413 |
| Made into coke at mines |  |  |  | 13, 561, 848 |  |

## COAL DELIVERED TO FOREIGN AND COASTWISE STEAMSHIPS, FOR THEIR OWN FUEL, AT THE PORTS NAMED, INCLUDED IN FIGURES GIVEN ABOVE OF DISTRIBUTION FOR CONSUMPTION.

[Short tons.]

| PORTS. | Bituminous. | Anthracite. |
|---|---|---|
| New York | 1, 291, 271 | 131, 624 |
| Philadelphia | 297, 609 |  |
| Baltimore | 227, 000 |  |
| Boston | 70, 267 | 17, 119 |
| Other Atlantic and Gulf ports | 80, 000 |  |
| Pacific Coast ports | 93, 000 |  |

### AMOUNT OF COAL CONSUMED IN THE PRINCIPAL CITIES OF THE UNITED STATES DURING THE YEAR 1889.

[Short tons.]

| CITIES. | Population, 1890. | Anthracite. | Bituminous. |
|---|---|---|---|
| New York, New York | 1, 515, 301 | *a*3, 300, 000 | 1, 853, 436 |
| Chicago, Illinois | 1, 099, 850 | 1, 444, 250 | 3, 221, 008 |
| Philadelphia, Pennsylvania | 1, 046, 964 | 3, 188, 094 | 919, 187 |
| Brooklyn, New York | 806, 343 | *a*1, 800, 000 | 200, 000 |
| Saint Louis, Missouri | 451, 770 | 85, 658 | 2, 125, 391 |
| Boston, Massachusetts | 448, 477 | 1, 242, 001 | 524, 409 |
| Baltimore, Maryland | 434, 439 | 414, 928 | 693, 685 |
| San Francisco, California | 298, 997 | 29, 800 | 375, 012 |
| Cincinnati, Ohio | 296, 908 | 30, 904 | 1, 030, 948 |
| Cleveland, Ohio | 261, 353 | 117, 157 | 924, 602 |
| Buffalo, New York | 255, 664 | 333, 653 | 1, 032, 791 |
| New Orleans, Louisiana | 242, 039 | 12, 107 | 435, 299 |
| Pittsburg, Pennsylvania | 238, 617 | 2, 294 | 334, 035 |
| Washington, District of Columbia | 230, 392 | 481, 088 | 45, 050 |
| Detroit, Michigan | 205, 876 | 214, 397 | 478, 993 |
| Milwaukee, Wisconsin | 204, 468 | 402, 774 | 262, 089 |
| Newark, New Jersey | 181, 830 | 410, 918 | 133, 158 |
| Minneapolis, Minnesota | 164, 738 | 94, 058 | 172, 648 |
| Jersey City, New Jersey | 163, 003 | 334, 328 | 132, 602 |
| Louisville, Kentucky | 161, 129 | 1, 981 | 380, 326 |
| Omaha, Nebraska | 140, 452 | 41, 279 | 244, 357 |
| Rochester, New York | 133, 896 | 280, 229 | 119, 667 |
| Saint Paul, Minnesota | 133, 156 | 83, 675 | 171, 367 |
| Kansas City, Missouri | 132, 716 | 59, 353 | 306, 607 |
| Providence, Rhode Island | 132, 146 | 349, 641 | 155, 985 |
| Denver, Colorado | 106, 713 | 10, 118 | 300, 841 |
| Indianapolis, Indiana | 105, 436 | 11, 930 | 277, 278 |
| Allegheny, Pennsylvania | 105, 287 | 1, 591 | 100, 674 |
| Albany, New York | 94, 923 | 104, 012 | 135, 031 |
| Columbus, Ohio | 88, 150 | 4, 229 | 258, 727 |
| Syracuse, New York | 88, 143 | 179, 891 | 84, 327 |
| Worcester, Massachusetts | 84, 655 | 87, 322 | 125, 555 |
| Toledo, Ohio | 81, 434 | 93, 583 | 153, 968 |
| Richmond, Virginia | 81, 388 | 38, 233 | 210, 232 |
| New Haven, Connecticut | 81, 298 | 98, 943 | 170, 359 |
| Paterson, New Jersey | 78, 347 | 202, 290 | 24, 250 |
| Lowell, Massachusetts | 77, 696 | 71, 150 | 185, 698 |
| Nashville, Tennessee | 76, 168 | .......... | 231, 300 |
| Scranton, Pennsylvania | 75, 215 | 422, 160 | 9, 985 |
| Fall River, Massachusetts | 74, 398 | 110, 745 | 95, 617 |
| Atlanta, Georgia | 65, 533 | 1, 269 | 208, 554 |
| Memphis, Tennessee | 64, 495 | 45 | 172, 669 |
| Wilmington, Delaware | 61, 431 | 158, 614 | 128, 515 |
| Dayton, Ohio | 61, 220 | 4, 802 | 178, 314 |
| Troy, New York | 60, 956 | 84, 177 | 102, 145 |
| Grand Rapids, Michigan | 60, 278 | 34, 717 | 104, 558 |
| Reading, Pennsylvania | 58, 661 | 331, 944 | 59, 902 |
| Camden, New Jersey | 58, 313 | 108, 838 | 67, 308 |
| Trenton, New Jersey | 57, 458 | 148, 554 | 132, 840 |
| Charleston, South Carolina | 54, 955 | 37, 259 | 31, 589 |

*a* Figures approximated.

The statement following shows the quantity of coal of all kinds received at and shipped from the principal points of transshipment in the United States during the calendar year 1889, including the coal for local consumption, together with that handled at the docks and storage points, but exclusive of that passing in trains or vessels on through consignment.

### COAL OF ALL KINDS RECEIVED AND SHIPPED.

[Short tons.]

| POINTS OF SHIPMENT. | RECEIVED. | | SHIPPED. | |
|---|---|---|---|---|
| | Anthracite. | Bituminous. | Anthracite. | Bituminous. |
| New York harbor | 10,253,706 | 4,353,436 | 7,202,581 | 2,500,000 |
| Philadelphia, Pennsylvania | 4,751,175 | 2,620,562 | 1,863,787 | 1,689,790 |
| Baltimore, Maryland | 512,928 | 2,202,063 | 98,630 | 1,508,378 |
| Boston, Massachusetts | 1,660,001 | 984,409 | 417,989 | 463,622 |
| Buffalo, New York | 2,480,035 | 1,126,765 | 2,146,382 | 93,994 |
| Cleveland, Ohio | 154,186 | 1,823,165 | 37,031 | 898,563 |
| Cincinnati, Ohio | 30,902 | 2,330,948 | ............ | 1,300,000 |
| Chicago, Illinois | 1,698,955 | 3,616,876 | 555,705 | 467,364 |
| Milwaukee, Wisconsin | 665,774 | 277,089 | 263,000 | 115,000 |
| Louisville, Kentucky | 1,981 | 1,378,326 | ............ | 1,000,000 |
| Saint Louis, Missouri | 112,620 | 2,225,391 | 26,962 | 100,000 |
| Kansas City, Missouri | 99,353 | 856,607 | 40,000 | 550,000 |
| New Orleans, Louisiana | 12,107 | 535,299 | ............ | 100,000 |
| Norfolk, Virginia | 11,104 | 1,143,958 | ............ | 1,077,111 |
| Toledo, Ohio | 121,124 | 712,538 | 57,459 | 587,500 |
| Duluth harbor, including Superior, Ashland, Gladstone, and Washburn. | ............ | ............ | 414,648 | 1,110,641 |
| Oswego, New York | ............ | ............ | 652,712 | 1,251 |
| Fair Haven and Sodus Point, New York | ............ | ............ | 176,388 | 4,202 |
| Charlotte, New York | ............ | ............ | 225,184 | 125,199 |
| Erie, Pennsylvania | ............ | ............ | 258,560 | 110,360 |
| Ashtabula, Ohio | ............ | ............ | ............ | 499,398 |
| Fairport, Ohio | ............ | ............ | ............ | 65,405 |
| Lorain, Ohio | ............ | ............ | ............ | 249,810 |

The above figures include all coal used by railroad companies and delivered to steam vessels at the points named for their own fuel.

## ALABAMA.

The coal fields of Alabama form the southern extremity of the great Appalachian coal fields, the northern limit of which lies along the western New York and Pennsylvania state line, and extends southwestward through portions of Pennsylvania, Maryland, West Virginia, Virginia, Ohio, Kentucky, Tennessee, Alabama, and Georgia. The coal deposits of Alabama are known to underlie the whole or portions of the counties of Franklin, Lawrence, Morgan, Marshall, Jackson, Dekalb, Cherokee, Marion, Winston, Cullman, Etowah, Blount, Walker, Fayette, Saint Clair, Jefferson, Tuscaloosa, Shelby, and Bibb. The state geological survey of Alabama estimates that the coal deposits embrace an area of 8,660 square miles, although actual mining operations are conducted in but 10 counties, viz, Blount, Cherokee, Tuscaloosa, Jefferson, Etowah, Saint Clair, Bibb, Shelby, Walker, and Cullman. This region is divided into 3 distinct districts. That portion drained by the Warrior river and its tributaries and the Tennessee river and its tributaries in Alabama constitutes the Warrior coal field. The Coosa field is situated in Saint Clair and Shelby counties, and is drained by the Coosa river. The Cahaba field lies along the Cahaba river, in the counties of Shelby, Jefferson, and Tuscaloosa.

The coals of Alabama embrace all the bituminous varieties, such as gas, coking, block, splint, and cannel, thereby providing the rapidly developing industries and increasing population of the state with an inexhaustible supply of fuel for furnace, steam, and domestic uses.

Mining of coal was begun in this state about the year 1853, but the total output, which was produced mainly by small operators for local consumption, did not reach 100,000 tons until the year 1876. The production for the census year 1880 was 323,972 tons, valued at $476,911 at the mines. The growth of the industry thenceforward has been almost phenomenal, the product for the calendar year 1889 being 3,572,983 short tons, valued at $3,961,491. The average number of persons employed during the year, including superintendents, engineers, mechanics, and clerical force, was 6,975, and the amount of wages paid was $3,267,857. The figures above given apply exclusively to the mining of coal and preparing it for shipment, all expenditures for the manufacture and handling of coke being excluded. The average number of days when mines were shipping coal was 196 during the year 1889.

The following lines of railroad traverse the coal fields of Alabama and provide facilities for the transportation of the product:

### RAILROADS TRAVERSING THE ALABAMA COAL FIELDS.

Alabama Great Southern railroad.
Louisville and Nashville railroad.
Kansas City, Memphis and Birmingham railroad.
Birmingham, Sheffield and Tennessee River railroad.
Georgia Pacific railway.
East Tennessee, Virginia and Georgia railroad.
East and West Railroad of Alabama.
Cahaba Coal Mining railroad.

## COAL PRODUCT OF ALABAMA IN 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | MINES. | | Total product of coal of all grades for year 1889. | DISPOSITION OF TOTAL PRODUCT. | | | | | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Regular. | Local. | | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | Manufactured into coke. | | |
| Total | 57 | 22 | 3, 572, 983 | 2, 327, 209 | 38, 835 | 21, 110 | 79, 515 | 1, 106, 314 | $3, 961, 491 | $1. 11 |
| Bibb | 10 | ...... | 500, 525 | 363, 102 | 1, 414 | ...... | 17, 590 | 118, 419 | 604, 230 | 1. 21 |
| Blount | ...... | 6 | 164 | ...... | 164 | ...... | ...... | ...... | 273 | 1. 66 |
| Cherokee | ...... | 1 | 40 | ...... | 40 | ...... | ...... | ...... | 80 | 2. 00 |
| Cullman | ...... | 2 | 300 | ...... | 300 | ...... | ...... | ...... | 600 | 2. 00 |
| Etowah | ...... | 7 | 4, 751 | ...... | 4, 751 | ...... | ...... | ...... | 8, 325 | 1. 75 |
| Jefferson | 21 | 1 | 2, 437, 446 | 1, 399, 264 | 21, 883 | 18, 694 | 49, 208 | 948, 397 | 2, 618, 777 | 1. 07 |
| Saint Clair | 2 | ...... | 40, 557 | 21, 922 | 540 | 630 | 2, 840 | 14, 625 | 50, 518 | 1. 25 |
| Shelby | 3 | ...... | 84, 833 | 54, 361 | ...... | 327 | 5, 272 | 24, 873 | 152, 166 | 1. 79 |
| Tuscaloosa | 6 | 4 | 16, 141 | 8, 600 | 6, 753 | 238 | 550 | ...... | 19, 796 | 1. 23 |
| Walker | 15 | 1 | 488, 226 | 479, 960 | 2, 990 | 1, 221 | 4, 055 | ...... | 506, 726 | 1. 04 |

## LABOR AND WAGES AT ALABAMA COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mine. | ABOVE GROUND. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total average number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Total | 6, 864 | 1, 018 | 57 | $2. 52 | 276 | 123 | $2. 12 | 231 | 797 | $1. 25 | 218 | 41 | $0. 62 | 212 |
| Jefferson | 4, 285 | 544 | 32 | 2. 43 | 306 | 78 | 2. 14 | 230 | 427 | 1. 30 | 220 | 7 | 0. 65 | 205 |
| Bibb, Tuscaloosa, Saint Clair, and Shelby. | 1, 615 | 344 | 11 | 2. 44 | 234 | 25 | 1. 81 | 224 | 294 | 1. 13 | 218 | 14 | 0. 64 | 227 |
| Walker | 964 | 130 | 14 | 2. 82 | 242 | 20 | 2. 41 | 249 | 76 | 1. 42 | 212 | 20 | 0. 60 | 203 |

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total average number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Total | 5, 846 | 73 | $2. 74 | 272 | 4, 110 | $2. 15 | 248 | 1, 564 | $1. 33 | 237 | 90 | $0. 66 | 224 | $3, 157, 109 |
| Jefferson | 3, 741 | 39 | 2. 70 | 280 | 2, 803 | 2. 11 | 262 | 852 | 1. 33 | 270 | 47 | 0. 68 | 229 | 2, 168, 604 |
| Bibb, Tuscaloosa, Saint Clair, and Shelby. | 1, 271 | 21 | 2. 82 | 277 | 668 | 2. 16 | 220 | 559 | 1. 34 | 194 | 23 | 0. 63 | 226 | 584, 040 |
| Walker | 834 | 13 | 2. 71 | 240 | 639 | 2. 37 | 214 | 153 | 1. 33 | 212 | 20 | 0. 65 | 216 | 404, 465 |

## EXPENDITURES AT ALABAMA COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| Total | 111 | $110, 748 | 110 | $110, 388 | 1 | 360 | 6, 975 | $3, 267, 857 | $261, 512 | $161, 046 | $3, 690, 415 | $36, 524 | $3, 726, 939 |
| Bibb | 14 | 16, 133 | 14 | 16, 133 | ...... | ...... | 1, 033 | 405, 822 | 34, 668 | 53, 012 | 493, 502 | ...... | 493, 502 |
| Jefferson | 56 | 54, 575 | 55 | 54, 215 | 1 | 360 | 4, 341 | 2, 223, 179 | 183, 847 | 62, 489 | 2, 469, 515 | 27, 924 | 2, 497, 439 |
| Saint Clair | 2 | 2, 200 | 2 | 2, 200 | ...... | ...... | 211 | 46, 105 | 3, 420 | 2, 500 | 52, 025 | 250 | 52, 275 |
| Shelby | 11 | 12, 400 | 11 | 12, 400 | ...... | ...... | 329 | 141, 001 | 18, 111 | 9, 798 | 168, 910 | ...... | 168, 910 |
| Tuscaloosa | 4 | 5, 150 | 4 | 5, 150 | ...... | ...... | 73 | 26, 995 | 1, 375 | 5, 729 | 34, 099 | 8, 350 | 42, 449 |
| Walker | 24 | 20, 290 | 24 | 20, 290 | ...... | ...... | 988 | 424, 755 | 20, 091 | 27, 518 | 472, 364 | ...... | 472, 364 |

### VALUE OF AND POWER AT ALABAMA COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | | | POWER USED IN MINING. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | Steam boilers. | | Number of cylinders. | Number of animals employed. |
| | Acres. | Value. | Acres. | Value. | | | | | | Number. | Horse power. | | |
| Total | 216, 129 | $9, 476, 341 | 6, 620 | $161, 600 | $1, 231, 228 | $1, 248, 159 | $12, 117, 328 | $417, 866 | $12, 535, 194 | 165 | 5, 582 | 114 | 532 |
| Bibb | 26, 631 | 1, 429, 792 | ........ | .......... | 204, 493 | 13, 950 | 1, 648, 235 | 67, 080 | 1, 715, 315 | 1 | 20 | .......... | 48 |
| Jefferson | 144, 534 | 6, 109, 479 | 1, 760 | 74, 200 | 815, 414 | 998, 522 | 7, 997, 615 | 254, 906 | 8, 252, 521 | 126 | 3, 950 | 72 | 351 |
| Saint Clair and Shelby. | 12, 585 | 613, 850 | 2, 600 | 26, 000 | 74, 857 | 124, 202 | 838, 909 | 30, 400 | 869, 309 | 20 | 880 | 22 | 34 |
| Tuscaloosa | 3, 192 | 77, 600 | ........ | .......... | 12, 500 | 15, 500 | 105, 600 | 10, 300 | 115, 900 | 4 | 105 | 7 | 6 |
| Walker | 29, 187 | 1, 245, 620 | 2, 260 | 61, 400 | 123, 964 | 95, 985 | 1, 526, 969 | 55, 180 | 1, 582, 149 | 14 | 627 | 13 | 93 |

## ALASKA.

At Coal Harbor there are 3 distinct seams in a sandstone formation, which dips to the northwest at an inclination of from 3° to 5° from the horizontal. The exposures are discernible in the face of a perpendicular bluff above high water, but the dip carries the seams under the surface of the bay a short distance to the north. The principal one can be traced for a considerable space under the water. The seams are separated apparently by fire clay. The lowest is at least 8 feet thick, the next 4 to 5 feet, and the upper not more than 3 feet. The coal is lignite of good quality, and the field is of considerable extent. It has been burned satisfactorily, and contains little sulphur.

The existence of these coal seams was well known to the Russians, but they were not worked by them because of outcropping upon the beach, and as they could only be successfully worked through perpendicular shafts of considerable depth, the Russians preferred to commence operations at some other point, where so large an outlay of capital would not be required. They accordingly proceeded to open a mine on the shore of a small cove, known as Coal bay, in Graham harbor, about 20 miles to the southwest of the entrance to Chugachik bay, and for a number of years mined from a single shaft all the coal the Russian-American Company required for use in its steamers. The company made the mistake, however, of following the seam under the bay, and, having cut a stream of water, the mine was flooded beyond hope of redemption. Subsequently, about the year 1851, a company was formed at San Francisco, to which the Russian-American Company was a party, for the purpose of mining coal for the San Francisco market, and a new mine near the old one was opened, under the local management of a German engineer named Haltern, and from that time until the sale of the territory to this government considerable coal was mined, though very little of it found its way to San Francisco. With the transfer of the country to the United States all efforts at coal mining ceased, and nothing has since been done looking to the practical development of the extensive coal measures on Cook inlet and elsewhere in Alaska.

Mr. Ivan Petroff, special agent of the Eleventh Census, makes the following report respecting the coal deposits of Alaska:

> Of other minerals [besides gold and silver] only coal has thus far been prospected, and it has been discovered in various parts of the territory. The veins thus far located show only lignite coal, some of which is of the best quality. At the present writing the only one of these coal veins operated is situated on Herendeen bay, on the north side of the Alaskan peninsula. The product of this mine was tested for the first time during the summer of 1890, and although the surface yield did not prove very satisfactory in steam-making qualities, there is every prospect of better coal being secured as the deeper layers of the mineral are reached. This mine has the advantage of being accessible both from Bering sea and the North Pacific ocean, 2 deep bays being separated only by a narrow isthmus 13 miles in width, over which a railway will be built in the near future. Some veins of coal near Cape Lisburne, on the Arctic coast, are utilized annually by whale ships and revenue cutters to replenish their stock of fuel, but have not been systematically worked. Another coal mine is being developed on Kuchekmak gulf, at the mouth of Cook inlet, but this deposit has not advanced beyond the prospecting stage, its nature being lignitic, like all other veins previously mentioned.

## ARKANSAS.

The coal deposits of Arkansas are located in the western part of the state, upon either side of the Arkansas river, extending, with more or less persistency, between Fort Smith and Little Rock. Mining operations have been conducted in Sebastian, Logan, Franklin, Crawford, Johnson, and Pope counties. The local districts are known by the following names:

Western or Sebastian County district.
Coal Hill district.
Philpott district.
Ouita district.

The principal lines of transportation for the product are as follows:

Little Rock and Fort Smith railroad.
Saint Louis and San Francisco railroad.
Missouri Pacific railroad.

The coals of Arkansas are variable in quality, and are adapted for steaming, coking, gas manufacture, and domestic purposes. Coal mining in this state may be said to have begun about the year 1870, but it did not assume commercial importance until about 1883. The quantity reported as being mined in the state during the census year ended June 30, 1880, was 14,778 short tons, valued at $33,535 at the mines. The total number of persons employed was 130, and the total wages paid, $20,850. The quantity of coal mined in the state during the calendar year 1889 was 279,584 short tons, valued at $395,836; the number of persons employed, 686, and the total wages paid, $252,679.

### COAL PRODUCT OF ARKANSAS IN 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | MINES. | | Total product of coal of all grades for year 1889. | DISPOSITION OF TOTAL PRODUCT. | | | | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|---|
| | Regular. | Local. | | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | | |
| Total | 11 | 16 | 279,584 | 268,518 | 5,020 | 1,800 | 4,246 | $395,836 | $1.42 |
| Franklin | | 8 | 1,688 | | 1,688 | | | 4,125 | 2.44 |
| Johnson | 4 | 1 | 105,998 | 103,018 | 680 | 400 | 1,900 | 156,067 | 1.47 |
| Pope | 1 | 1 | 6,014 | 4,214 | 1,200 | | 600 | 11,491 | 1.91 |
| Sebastian | 6 | 6 | 165,884 | 161,286 | 1,452 | 1,400 | 1,746 | 224,153 | 1.35 |

### LABOR AND WAGES AT ARKANSAS COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mine. | ABOVE GROUND. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total average number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Total | 677 | 116 | 5 | $2.63 | 248 | 21 | $2.22 | 208 | 79 | $1.49 | 210 | 11 | $0.70 | 159 |
| Johnson and Pope | 172 | 40 | 2 | 3.40 | 305 | 5 | 2.25 | 208 | 33 | 1.40 | 271 | | | |
| Sebastian | 505 | 76 | 3 | 2.00 | 210 | 16 | 2.21 | 208 | 46 | 1.59 | 166 | 11 | 0.70 | 159 |

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total average number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Total | 561 | 10 | $2.71 | 228 | 462 | $2.20 | 180 | 64 | $2.00 | 186 | 25 | $0.71 | 199 | $248,899 |
| Johnson and Pope | 132 | 4 | 2.81 | 284 | 99 | 2.42 | 260 | 19 | 1.89 | 232 | 10 | 0.67 | 275 | 86,816 |
| Sebastian | 429 | 6 | 2.61 | 190 | 363 | 2.10 | 158 | 45 | 2.06 | 166 | 15 | 0.77 | 148 | 162,083 |

### EXPENDITURES AT ARKANSAS COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| Total | 9 | $3,780 | 9 | $3,780 | | | 686 | $252,679 | $39,158 | $16,874 | $308,711 | | $308,711 |
| Johnson and Pope | 3 | 1,205 | 3 | 1,205 | | | 175 | 88,021 | 24,436 | 15,383 | 127,840 | | 127,840 |
| Sebastian | 6 | 2,575 | 6 | 2,575 | | | 511 | 164,658 | 14,722 | 1,491 | 180,871 | | 180,871 |

### VALUE OF AND POWER AT ARKANSAS COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | | | | POWER USED IN MINING. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | Steam boilers. | | Number of cylinders. | Other power. | | |
| | | | | | | | | | | | | | Motors. | | Number of animals employed. |
| | Acres. | Value. | Acres. | Value. | | | | | | Number. | Horse power. | | Number. | Horse power. | |
| Total | 15,969 | $1,041,876 | 1,095 | $55,750 | $77,098 | $77,777 | $1,252,501 | $37,250 | $1,289,751 | 20 | 895 | 6 | 3 | 22 | 75 |
| Johnson and Pope. | 1,300 | 61,500 | 1,095 | 55,750 | 19,610 | 38,650 | $175,510 | 11,890 | 187,400 | 10 | 565 | 6 | ...... | ........ | 20 |
| Sebastian | 14,669 | 980,376 | ........ | ........ | 57,488 | 39,127 | 1,076,991 | 25,360 | 1,102,351 | 10 | 330 | .......... | 3 | 22 | 55 |

## CALIFORNIA AND OREGON.

Although coal deposits of more or less importance have been discovered in many of the counties of California west of the Sierras from Siskiyou, in the vicinity of Mount Shasta, in the north, to San Diego, in the south, no mining operations upon a commercial scale have been prosecuted except in Amador and Contra Costa counties. Coal was discovered in the Mount Diablo district in 1852, but productive mining was not prosecuted until after the year 1860. This district now furnishes the major portion of the product of the state. The coals of California, so far as at present known, are all lignitic in character, generally inferior to the coals of Washington and Oregon, and can not compete with the better coals supplied by sea from British Columbia and Australia.

The total product of coal in California during the calendar year 1889 was 119,820 short tons, valued at $270,732, showing an average price of $2.26 per ton at the mines. The average number of persons employed during the year was 283, and the total wages paid $169,649.

Considerable interest has been manifested in recent years in the subject of an adequate fuel supply for the increasing demands of the state, which has resulted in more determined and well-directed research. From the reported recent discoveries of coal beds in various sections of the state, the belief exists that the time is not far distant when California will cease to be dependent upon foreign coals for its requirements.

The fuel supply of California has been derived from the following sources during the year 1889:

### SOURCES OF COAL CONSUMED IN CALIFORNIA IN 1889.

| | SHORT TONS. |
|---|---|
| British Columbia | 417,904 |
| Australia and Japan | 409,372 |
| England, Scotland, and Wales | 45,617 |
| Eastern anthracite and bituminous | 18,950 |
| Washington | 372,514 |
| Mount Diablo and Coos bay | 87,600 |
| Total | 1,351,957 |

Outcroppings of coal have been found in 19 counties in the state of Oregon, both east and west of the Cascade range, but mining operations are reported only in Coos county. These mines are located at Marshfield, on Coos bay, and are operated by the Oregon Coal and Navigation Company. The Coos county field is claimed to cover an area of several hundred square miles, and produces a fair quality of lignite. The product is shipped mainly to San Francisco.

### COAL PRODUCT IN CALIFORNIA AND OREGON IN 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | MINES. | | Total product of coal of all grades for year 1889. | DISPOSITION OF TOTAL PRODUCT. | | | | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|---|
| | Regular. | Local. | | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | | |
| Total | 9 | 1 | 184,179 | 173,611 | 3,854 | 608 | 6,106 | $434,382 | $2.36 |
| Amador, California | 2 | ........ | 40,900 | 39,500 | 500 | 50 | 850 | 75,075 | 1.84 |
| Contra Costa, California | 2 | ........ | 64,945 | 63,221 | ................ | 336 | 1,388 | 161,190 | 2.48 |
| Fresno, California | 2 | ........ | 8,100 | 5,000 | ................ | 50 | 3,050 | 17,859 | 2.20 |
| Monterey, California | 1 | ........ | 672 | 392 | ................ | 22 | 258 | 3,600 | 5.36 |
| San Bernardino, California | 1 | ........ | 5,203 | 3,015 | 2,178 | 10 | ................ | 13,008 | 2.50 |
| Coos, Oregon | 1 | 1 | 64,359 | 62,483 | 1,176 | 140 | 560 | 163,650 | 2.54 |

LABOR AND WAGES AT CALIFORNIA AND OREGON COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mine. | ABOVE GROUND. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total average number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| **Amador, Contra Costa, Fresno, Monterey, and San Bernardino, California, and Coos, Oregon.** | 413 | 76 | 6 | $5.12 | 296 | 20 | $2.90 | 236 | 48 | $2.04 | 248 | 2 | $1.50 | 240 |

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total average number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days. worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| **Amador, Contra Costa, Fresno, Monterey, and San Bernardino, California, and Coos, Oregon.** | 337 | 9 | $3.17 | 271 | 235 | $2.58 | 224 | 85 | $2.32 | 268 | 8 | $1.47 | 239 | $241,249 |

EXPENDITURES AT CALIFORNIA AND OREGON COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| **Amador, Contra Costa, Fresno, Monterey, and San Bernardino, California, and Coos, Oregon.** | 6 | $7,200 | 6 | $7,200 | .......... | .......... | 419 | $248,449 | $56,678 | $43,590 | $348,717 | $16,225 | $364,942 |

VALUE OF AND POWER AT CALIFORNIA AND OREGON COAL MINES IN 1889, BY COUNTRIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | Number of animals employed. |
|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | |
| | Acres. | Value. | | | | | | |
| **Amador**, Contra Costa, Fresno, Monterey, and San Bernardino, California, and Coos, Oregon. | 4,012 | $238,400 | $157,500 | $94,400 | $490,300 | $36,450 | $526,750 | 57 |

## COLORADO.

The following in relation to the coal fields of Colorado is taken from a recent address delivered by Professor Arthur Lakes, of the Colorado State School of Mines, before the Manufacturers' Exchange of Denver:

Few have an idea of the size of our comparatively new coal fields, of the number and thickness of the seams they contain, and of the excellent quality of the coals. It has been by no means easy to convince eastern men either of the quality of the Colorado coal or of the area of its field, as compared with similar data of eastern states. Colorado coals have long been thought of as "lignites", little better than peat, owing to the fact that they were so called by Professor Hayden in his report of 1873. This was true enough for the northern field about Boulder, but wholly unjust as to the great bulk of the coal fields, which produce bituminous coal. There are coals that not only produce good coke, some of it equal to that of Connellsville, but even anthracite, limited in quantity, similar to that of the eastern states. The fields belong geologically to a more recent period than those of Pennsylvania, these being cretaceous, Pennsylvania's carboniferous; but what old age and pressure have done for the eastern coals has been accomplished here by the heat of volcanic eruptions attendant upon mountain upheaval.

### NORTHERN COLORADO COAL FIELD.

This field extends north from Boulder into the Laramie plains of Wyoming and south to Colorado Springs. Its approximate eastern boundary is a line drawn north and south some 40 miles east of the mountains. This field has long been developed in Boulder county by the Marshall, Erie, and Louisville mines. Marshall is one of the oldest mines in the state, having been worked for at least 20 years. By a series of faults, accompanied by erosion, the coal has locally been brought near to the surface at a gentle dip of 5 degrees. The principal seam is 6 to 8 feet thick. The coal is a good, pure, high-class lignitic coal, not coking, but well adapted to all purposes where extraordinary heat is not required. A large area has been worked out, a good deal burned out by spontaneous combustion, and an unknown amount presumably left. The development is sometimes impeded by the faults, which cut off the continuity of a seam. From Franceville for about 30 miles south there are no developments until we reach Cañon City, on the south bank of the Arkansas river, where is a small isolated field, 12 miles long by 2 miles broad, carrying a seam 4 to 5 feet wide of noncoking bituminous coal, which has long been a favorite fuel owing to its high calorific power and general purity. The gentle dip of the strata admits extensive development.

### THE SOUTHEASTERN FIELD.

From the Arkansas river to the Huerfano river, a distance of 50 miles, is another barren space, and then the northern extremity of the great Raton plateau and Raton coal fields is met. Some of this coal has been burned, or changed into natural, but worthless, coke by volcanic dikes, with which the region abounds. As a whole, however, it represents an enormous amount of bituminous domestic and coking coal. The cause of this change from a lignitic to a bituminous and coking character may be found in the great volcanic manifestations of this area.

Crossing the Sangre de Cristo range from the fields of the eastern slope no coal is seen for over 100 miles, but from the Conejos range a region of endless plateaus is overlooked, representing the La Plata coal fields. Over this large area there are but half a dozen small mines. One body of coal on the Animas river, below Durango, is 70 feet thick, caused by the running together of several seams. It is developed at the Carbonero and La Plata mines. This great body is traceable for several miles along the "hogbacks" by a valley caused by the washing out of the softer coal. The individual seams composing this mammoth body can be worked separately to advantage, but worked collectively the result would be a high per cent of ash, from the admixture of coal "partings." Close to the town of Durango a seam 5 feet thick of excellent quality is worked by the San Juan and Porter mines. The coal of all these seams makes very good coke, but the market for it is at present local. The drawbacks to this coal field are its distance from the main central market, the presence of only 1 line of railroad, and the proximity of the Ute reservation. When some of these obstacles are removed there is a good future for the region.

### FIELDS OF NORTHWESTERN COLORADO.

In the Crested Butte region there is a small portion of the Grand River field isolated by a circle of volcanic mountains, forming the Elk range. The heat from these volcanic sources has altered the coal into the several varieties of bituminous, coking, and semianthracite, the alteration being more or less great, according to distance from volcanic heat. The anthracite portion is limited to a mesa of about 500 acres, where the seam is 6 feet thick and yields an anthracite as hard and lustrous as that of Pennsylvania. Its composition is:

COMPOSITION OF COLORADO ANTHRACITE.

| | PER CENT. |
|---|---|
| Water | 1.56 |
| Volatile matter | 5.93 |
| Fixed carbon | 88.76 |
| Ash | 3.75 |
| Total | 100.00 |

The coal of the Grand River field has a further importance from its close proximity to the greatest iron deposits so far discovered in Colorado, such as those of the Iron King at White Pine, near Gunnison City, and the Cumberland iron mine, also within fair distance of this great coal field. The Grand River field lies on the drainage of the Grand river and its tributaries in Pitkin, Garfield, and Mesa counties, and a detached portion of it on White and Yampa rivers. The coal of the southern end, beginning from Crested Butte, is traceable around Mount Carbon to the Baldwin mines, thence west to Gunnison mountain, where, on Coal creek, are large seams of semicoking and coking coal, with some anthracite. From Mount Gunnison the coal outcrop is followed across the north fork of the Gunnison, around Grand Mesa to Hogback cañon on the Grand river, where, 16 miles above Grand Junction, seams of domestic bituminous coal 6 to 8 feet thick appear on the sides of the cañon; thence to the Utah line along the Little Book cliffs to Green river, and beyond the coal probably underlies a large tract of country east of the Wahsatch mountains. From New Castle the coal follows the course of the hogback to Meeker, a distance of 40 miles. Thence it bends in a curve in a northerly direction towards Yampa river, and appears again on White river below the mouth of the Piceance creek. After this it follows the Uintah range into Utah and Grand river. In the coal basin at Jerome Park and at the Marion and Sunshine mines, near Cardiff, on the Roaring Fork, which lie around such eruptive centers as Mount Sopris and the Elk range, the coal is largely coking, producing a coke of great purity, at times equal to that of Connellsville. Mr. R. C. Hill estimates the coking area of this district at 353 square miles. On the cliff face of the Great Hogback, 1,000 feet above the Grand river, many seams are exposed, varying in thickness from 22 feet near the base to 10 and 5 feet near the summit. The coal along this hogback is first-class bituminous domestic coal, not coking, but freer from soot than those of a coking nature. On the field around Meeker, owing to the absence from railroads and the distance from markets, little development has been done. The coal appears like that at New Castle.

### SOUTHWESTERN OR LA PLATA FIELD.

In southwestern Colorado the Rio Grande railway has entered and discovered another large field, covering thousands of square miles and extending from Colorado into New Mexico and Arizona, known as the La Plata field. Here is an immense amount of coal, in bodies from 5 to 70 feet in thickness; yet over this great area the development is restricted to some 4 or 5 small mines, 1 at Monero, 1 at Florida, and 3 or 4 about Durango, supplying a very local trade. This small development is due to the possession of much of the field by the Ute Indians, and to the fact that but 1 railroad penetrates the region. The coal is bituminous, and over certain areas makes fine coke.

## CLASSIFICATION OF COAL DISTRICTS OF COLORADO.

| DISTRICTS. | County. | DISTRICTS. | County. |
|---|---|---|---|
| Northwestern: | | Southern: | |
| Yampah | Routt. | Huerfano | Huerfano. |
| Meeker | Rio Blanco. | Trinidad | Las Animas. |
| Glenwood | Garfield. | | |
| Book Cliffs | Mesa. | Western: | |
| Rock Creek | Pitkin. | Crested Butte | Gunnison. |
| Northern: | | West Elk | Do. |
| North Park | Larimer. | Delta | Delta. |
| Golden | Jefferson. | | |
| Marshall | Boulder. | Southwestern: | |
| Erie | Weld. | La Plata | La Plata. |
| Central: | | Cortez | Montezuma. |
| Cañon City | Fremont. | Rico | Dolores. |
| South Park | Park. | San Miguel | San Miguel. |
| Franceville | El Paso. | | |

In 1880 the total output of coal in Colorado, as reported to the Tenth Census, was 462,747 short tons, valued at $1,041,350 at the mines; 1,434 persons were employed, and $714,714 paid in wages. During the calendar year 1889, the total production, as reported to the Eleventh Census, was 2,597,181 short tons, valued at $3,993,768, or $1.54 per ton, at the mines; 308,061 tons of this product was made into coke. There were 64 regular establishments in operation during the year, employing 4,973 persons. The amount paid in wages was $2,810,937.

The railroad systems reaching the coal regions of Colorado are as follows:

Atchison, Topeka and Santa Fe railway.
Denver and Rio Grande railway.
Union Pacific railway.
Burlington and Missouri River railway.
Denver, Texas and Fort Worth railway.
Santa Fe Southern railway.
Colorado Midland railway.
Chicago, Rock Island and Pacific railway.

## COAL PRODUCT IN COLORADO IN 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | MINES. | | Total product of coal of all grades for year 1889. | DISPOSITION OF TOTAL PRODUCT. | | | | | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Regular. | Local. | | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | Manufactured into coke. | | |
| Total | 64 | 40 | 2,597,181 | 2,109,335 | 70,895 | 20,353 | 88,537 | 308,061 | $3,993,768 | $1.54 |
| Arapahoe | 1 | | 823 | 50 | 713 | 24 | 36 | | 1,039 | 1.26 |
| Boulder | 20 | | 323,096 | 298,074 | 8,355 | 2,970 | 13,697 | | 494,569 | 1.53 |
| Delta | 1 | 2 | 1,357 | 11 | 1,322 | 24 | | | 2,391 | 1.76 |
| Douglas | | 2 | 260 | | 260 | | | | 520 | 2.00 |
| El Paso | 2 | | 54,212 | 49,450 | 3,375 | 409 | 978 | | 69,116 | 1.27 |
| Fremont | 4 | | 274,029 | 239,940 | 1,505 | 3,003 | 29,581 | | 581,125 | 2.12 |
| Garfield | 5 | | 239,292 | 200,607 | | | 150 | 38,535 | 393,260 | 1.64 |
| Gunnison | 4 | | 252,442 | 177,303 | 406 | 2,873 | 5,295 | 66,565 | 574,746 | 2.28 |
| Huerfano | 6 | | 333,717 | 309,617 | 756 | 884 | 22,460 | | 457,982 | 1.37 |
| Jefferson | 1 | 1 | 10,790 | 1,885 | 7,905 | | 1,000 | | 27,425 | 2.54 |
| La Plata | 6 | 1 | 34,971 | 14,393 | 7,558 | 38 | 3 | 12,979 | 66,855 | 1.91 |
| Larimer | | 1 | 100 | | 100 | | | | 150 | 1.50 |
| Las Animas | 12 | 1 | 993,534 | 756,064 | 27,070 | 9,831 | 10,587 | 189,982 | 1,157,022 | 1.16 |
| Mesa | | 2 | 1,100 | | 1,075 | 25 | | | 2,750 | 2.50 |
| Montezuma | | 7 | 816 | | 811 | 5 | | | 2,155 | 2.64 |
| Park | 1 | | 41,823 | 37,873 | 33 | 267 | 3,650 | | 104,223 | 2.49 |
| Rio Blanco | | 4 | 2,900 | | 2,900 | | | | 5,700 | 1.97 |
| Routt | | 12 | 1,491 | | 1,491 | | | | 2,246 | 1.51 |
| San Miguel | | 2 | 1,800 | | 1,800 | | | | 7,200 | 4.00 |
| Weld | 1 | 5 | 28,628 | 24,068 | 3,460 | | 1,100 | | 43,294 | 1.51 |

## LABOR AND WAGES AT COLORADO COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mine. | ABOVE GROUND. | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total average number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Total | 4,904 | 807 | 53 | $3.50 | 278 | 161 | $2.98 | 229 | 571 | $2.21 | 234 | 22 | $1.25 | 221 | |
| Arapahoe | 2 | 1 | | | | 1 | 2.25 | 309 | | | | | | | |
| Delta | 2 | | | | | | | | | | | | | | |
| Boulder | 717 | 105 | 17 | 3.02 | 258 | 32 | 2.98 | 211 | 56 | 2.50 | 179 | | | | |
| La Plata | 69 | 23 | 2 | 4.00 | 206 | 2 | 3.50 | 275 | 18 | 2.47 | 238 | 1 | 1.50 | 275 | |
| Fremont | 928 | 117 | 5 | 2.92 | 253 | 19 | 2.55 | 200 | 79 | 2.09 | 203 | 14 | 1.12 | 209 | |
| Gunnison | 489 | 98 | 3 | 3.15 | 324 | 13 | 3.13 | 221 | 81 | 2.52 | 271 | 1 | 1.75 | 282 | |
| Garfield | 366 | 54 | 4 | 4.75 | 278 | 18 | 3.00 | 240 | 32 | 2.33 | 227 | | | | |
| Jefferson | 16 | 5 | 1 | 3.00 | 313 | 2 | 3.00 | 313 | 2 | 2.50 | 280 | | | | |
| Park | 132 | 35 | 1 | 3.33 | 365 | 4 | 2.65 | 312 | 30 | 2.25 | 294 | | | | |
| Weld | 48 | 7 | 1 | 4.00 | 300 | 2 | 3.00 | 237 | 4 | 2.00 | 237 | | | | |
| El Paso | 124 | 24 | 3 | 3.78 | 322 | 7 | 2.71 | 258 | 14 | 2.20 | 179 | | | | |
| Las Animas | 1,354 | 169 | 11 | 3.64 | 284 | 25 | 3.34 | 226 | 130 | 2.22 | 255 | 3 | 1.33 | 230 | |
| Huerfano | 657 | 169 | 5 | 4.15 | 300 | 36 | 2.96 | 236 | 125 | 1.85 | 224 | 3 | 1.42 | 178 | |

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total average number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Total | 4,097 | 46 | $3.36 | 287 | 3,390 | $2.65 | 212 | 564 | $2.65 | 214 | 97 | $1.18 | 220 | $2,734,895 |
| Arapahoe | 1 | | | | 1 | 2.25 | 313 | | | | | | | 1,544 |
| Delta | 2 | | | | 2 | 2.40 | 81 | | | | | | | 389 |
| Boulder | 612 | 9 | 3.37 | 295 | 510 | 2.73 | 166 | 83 | 3.06 | 160 | 10 | 1.46 | 200 | 346,590 |
| La Plata | 46 | 1 | 4.00 | 312 | 42 | 3.02 | 251 | 2 | 2.75 | 275 | 1 | 1.60 | 66 | 50,577 |
| Fremont | 811 | 4 | 3.00 | 205 | 680 | 2.65 | 206 | 100 | 2.52 | 202 | 27 | 1.14 | 201 | 479,640 |
| Gunnison | 391 | 5 | 3.31 | 326 | 293 | 3.06 | 228 | 87 | 2.89 | 265 | 6 | 1.54 | 232 | 323,777 |
| Garfield | 312 | 4 | 3.43 | 328 | 234 | 3.00 | 220 | 74 | 2.75 | 178 | | | | 232,013 |
| Jefferson | 11 | 1 | 3.00 | 313 | 10 | 3.00 | 280 | | | | | | | 13,556 |
| Park | 97 | 1 | 3.33 | 365 | 64 | 3.00 | 312 | 32 | 2.97 | 294 | | | | 116,089 |
| Weld | 41 | 1 | 3.50 | 300 | 36 | 3.10 | 237 | 4 | 2.50 | 237 | | | | 35,244 |
| El Paso | 100 | 1 | 3.00 | 75 | 95 | 2.85 | 150 | 4 | 1.63 | 144 | | | | 55,231 |
| Las Animas | 1,185 | 11 | 3.32 | 275 | 1,038 | 2.42 | 232 | 104 | 2.22 | 234 | 32 | 1.12 | 249 | 755,435 |
| Huerfano | 488 | 8 | 3.49 | 298 | 385 | 2.49 | 204 | 74 | 2.52 | 202 | 21 | 1.09 | 212 | 324,810 |

## EXPENDITURES AT COLORADO COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| Total | 69 | $76,042 | 66 | $74,867 | 3 | $1,175 | 4,973 | $2,810,937 | $501,469 | $391,657 | $3,704,063 | $91,689 | $3,795,752 |
| Boulder | 12 | 12,415 | 10 | 11,640 | 2 | 775 | 729 | 359,005 | 62,379 | 67,041 | 488,425 | 32,292 | 520,717 |
| Fremont | 9 | 9,523 | 9 | 9,523 | | | 937 | 489,163 | 59,626 | 166,235 | 715,024 | | 715,024 |
| Garfield | 10 | 18,304 | 10 | 18,304 | | | 376 | 250,317 | 72,055 | 35,998 | 358,370 | | 358,370 |
| Gunnison | 6 | 5,390 | 6 | 5,390 | | | 495 | 329,167 | 61,961 | 19,325 | 410,453 | | 410,453 |
| Huerfano | 8 | 6,930 | 8 | 6,930 | | | 665 | 331,740 | 66,787 | 21,201 | 419,728 | | 419,728 |
| La Plata | 1 | 720 | 1 | 720 | | | 70 | 51,297 | 3,970 | 1,349 | 56,616 | | 56,616 |
| Las Animas | 19 | 18,560 | 18 | 18,160 | 1 | 400 | 1,373 | 773,995 | 128,967 | 57,242 | 960,204 | 59,397 | 1,019,601 |
| Arapahoe, Delta, El Paso, Jefferson, Park, and Weld. | 4 | 4,200 | 4 | 4,200 | | | 328 | 226,253 | 45,724 | 23,266 | 295,243 | | 295,243 |

VALUE OF AND POWER AT COLORADO COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | | | POWER USED IN MINING. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | Steam boilers. | | Other power. | | | |
| | | | | | | | | | | | | Motors. | | Number of machines. | Number of animals employed. |
| | Acres. | Value. | Acres. | Value. | | | | | | Number. | Horse power. | Number. | Horse power. | | |
| Total | 53,529 | $4,757,090 | 20,800 | $5,215,820 | $1,265,403 | $1,229,759 | $12,468,072 | $390,564 | $12,858,636 | 152 | 6,245 | 7 | 452 | 50 | 621 |
| Boulder | 4,672 | 304,800 | 980 | 124,000 | 125,987 | 290,740 | 845,527 | 70,875 | 916,402 | 40 | 1,940 | 5 | 412 | 39 | 72 |
| Fremont | 13,910 | 493,169 | 4,200 | 1,369,423 | 67,055 | 334,848 | 2,264,495 | 70,650 | 2,335,145 | 34 | 670 | ...... | ...... | 7 | 72 |
| Garfield | 9,610 | 710,561 | ...... | ...... | 180,647 | 36,003 | 927,211 | 42,000 | 969,211 | 12 | 406 | ...... | ...... | ...... | 46 |
| Gunnison | 1,040 | 14,400 | 2,260 | 219,949 | 59,900 | 102,662 | 396,911 | 41,300 | 438,211 | 13 | 480 | ...... | ...... | ...... | 78 |
| Huerfano | 5,852 | 1,550,435 | 2,000 | 951,198 | 332,851 | 78,472 | 2,912,956 | 45,100 | 2,958,056 | 22 | 1,070 | ...... | ...... | ...... | 83 |
| La Plata | 2,018 | 223,120 | 280 | 5,600 | 97,200 | 7,300 | 333,220 | 4,450 | 337,670 | 1 | 40 | ...... | ...... | 1 | 12 |
| Las Animas | 11,300 | 1,337,087 | 6,280 | 2,240,050 | 317,402 | 262,750 | 4,157,289 | 79,525 | 4,236,814 | 14 | 1,004 | 2 | 40 | ...... | 227 |
| Arapahoe, Delta, El Paso, Jefferson, Park, and Weld. | 5,127 | 123,518 | 4,800 | 305,600 | 84,361 | 116,984 | 630,463 | 36,664 | 667,127 | 16 | 635 | ...... | ...... | 3 | 31 |

## NORTH AND SOUTH DAKOTA.

The ascertained coal areas of these states lie in the western counties, between a line drawn from the Turtle mountains, in the north, through Burleigh county, to the southern borders of the Black Hills and the western boundary line. The principal developments have been made along the line of the Northern Pacific railway, near Bismarck, and westward at points along the Missouri river as far north as Fort Stevenson, and also in the vicinity of Hay creek, in the Black Hills. The product is a fair grade of lignite or brown coal, suitable for heating and steam, and in some localities it is said to be adapted for the manufacture of coke and gas. The seams vary in thickness from a few inches to 12 feet. The great heat evolved by this species of fuel, caused by too quick combustion when furnished with a direct draft, usual in the arrangements for steam raising for industrial purposes, is detrimental to the crown plates and furnace bars. Attention, however, has recently been directed to the manufacture of devices applicable to heating furnaces and domestic stoves and ranges by which these lignites may be more effectively and economically utilized. The absence of transportation facilities has hitherto retarded the development of the coal-mining industry, but under new conditions increasing demands will encourage railroad construction and stimulate a more intelligent prosecution of mining operations. The best authorities upon the subject look forward to a near future when the demands for fuel in these new and rapidly developing states will be readily supplied within their own borders.

The only mining operations conducted upon a commercial scale during the calendar year 1889 were in the vicinity of Sims, in Morton and Stark counties, and at Burlington, in Ward county. Local banks have been opened in Burleigh, Emmons, and McLean counties. Preparations are in progress for developing the extensive beds of coal known to underlie the section at the southern border of the Black Hills, in the vicinity of Hot Springs, in Fall River and Custer counties. It is reported that at the southeastern extremity of South Dakota a 6-foot vein of coal was struck at a depth of 350 feet, near Lodi, in Clay county, by parties boring for water, and a like find was made near Centreville, Turner county. This proving true, would indicate the existence in South Dakota of outlying basins more or less related to the great Fourth field, underlying a large portion of the transmississippi valley.

THE DAKOTA COAL DISTRICTS.

| NORTH DAKOTA. | | SOUTH DAKOTA. | |
|---|---|---|---|
| Districts. | Counties. | Districts. | Counties. |
| Turtle mountain | Bottineau. | Black Hills | Butte. |
| Do | Rolette. | Hot Springs | Custer. |
| Burlington | Ward. | Do | Fall River. |
| Sims | Stark. | Vermillion river | Turner. |
| Do | Morton. | Do | Clay. |
| Do | McLean. | | |
| Do | Burleigh. | | |
| Do | Emmons. | | |
| Little Missouri | Billings. | | |

No coal-mining operations were reported to the Tenth Census for Dakota. The reports of production as published by the United States geological survey in the years past have been mainly estimates. The output of all mines in North and South Dakota during the calendar year 1889 was 28,907 short tons, of which 7,292 tons were from ranchmen's diggings and local mines. The total product was valued at $41,431.

## COAL PRODUCT OF NORTH DAKOTA IN 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | Total product of coal of all grades for year 1889. | DISPOSITION OF TOTAL PRODUCT. | | | | | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|
| | | Loaded at mine for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | Manufactured into coke. | | |
| Total | 28, 907 | 18, 610 | 9, 792 | 505 | | | $41, 431 | $1. 43 |
| Burleigh | 1, 418 | | 1, 418 | | | | 2, 795 | 1. 97 |
| Emmons | 100 | | 100 | | | | 300 | 3. 00 |
| McLean | 1, 849 | | 1, 849 | | | | 4, 623 | 2. 50 |
| Morton | 16, 240 | 12, 210 | 3, 625 | 405 | | | 23, 313 | 1. 44 |
| Stark | 6, 300 | 5, 000 | 1, 300 | | | | 6, 650 | 1. 06 |
| Ward | 3, 000 | 1, 400 | 1, 500 | 100 | | | 3, 750 | 1. 25 |

## LABOR AND WAGES AT NORTH DAKOTA COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mine. | ABOVE GROUND. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total average number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Morton, Stark, and Ward | 75 | 13 | 7 | $2. 29 | 115 | 3 | $2. 67 | 88 | 3 | $1. 50 | 100 |

| COUNTIES. | BELOW GROUND. | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total average number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Morton, Stark, and Ward | 62 | 3 | $3. 00 | 117 | 55 | $2. 15 | 108 | 4 | $1. 88 | 111 | $17, 560 |

## EXPENDITURES AT NORTH DAKOTA COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | |
| Morton, Stark, and Ward. | 1 | $900 | 1 | $900 | | | 76 | $18, 460 | $2, 900 | $380 | $21, 740 | $21, 740 |

## VALUE OF AND POWER AT NORTH DAKOTA COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | Number of animals employed. |
|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | sh capital ot reported in the foregoing items. | Total capital. | |
| | Acres. | Value. | | | | | | |
| Morton, Stark, and Ward | 520 | $51, 700 | $5, 980 | $3, 820 | $61, 500 | $5, 080 | $66, 580 | 15 |

## GEORGIA AND NORTH CAROLINA.

### GEORGIA.

In the northeastern counties of the state of Georgia an area of about 200 square miles is underlaid by the eastern edge of the Appalachian coal field near its southern extremity, embracing portions of Dade and Walker counties. The Georgia Mining, Manufacturing and Investment Company has an extensive colliery at Coal City, which is connected by a lateral line with the Nashville, Chattanooga and Saint Louis railroad. The character of the coal is semibituminous. It yields a fair quality of coke. A large portion of the product at this mine is manufactured into coke for use at the furnaces of the company.

### NORTH CAROLINA.

Coal deposits exist in Stokes and Rockingham counties, along the Dan river, and in Chatham and Moore counties, in the valley of the Deep river. The state board of agriculture has given much attention to the exploration of these beds. Mr. H. B. Robson, the engineer who has been conducting these explorations, in his report to the Department of Agriculture upon the Dan river fields, says:

> From a careful observation of the coal areas encountered hitherto, I think I have found rapid transformation from soft to hard crystalline coal in the hill slope beds. I hope to find this latter condition in the deposits of the valley. This result will be of vast importance to the state, as well as to the district, adding to the coal resources not less than 40,000,000 tons of accessible coal. * * * The Dan river coal deposits may be taken as available for fuel consumption between Leaksville and Germantown, a distance of about 50 miles, the width of the basin between outcrops being about 3.5 miles. No coal has been found on the northwestern edge of the basin, but in the southeastern edge 2 available coal seams are found, which reach their maximum thickness (3 and 7 feet) southwest of the Dan river and within 10 miles of the southwestern end of the deposit.

The census investigation for the calendar year 1889 failed to find any coal operations in this region excepting a few unimportant country banks, whose product was so small and uncertain that answers to inquiries could not be obtained. The Egypt Coal Company, the only company in the state mining coal upon a commercial basis, is developing a property of about 2,700 acres in Chatham county, near Egypt depot. The product for 1889 was small, as mining was only begun in December of that year, but the progress made indicates a profitable industry. This mine is connected by siding with the Cape Fear and Yadkin Valley railway, which is providing an adequate supply of suitable rolling stock for the prompt disposition of this new and valuable traffic. A capacity of 500 tons per day has already been reached.

Considerable coal was taken from this mine during the late war to supply the arsenal at Fayetteville and for use of the blockade runners at Wilmington. Since that time, however, the mine has been almost entirely abandoned, and, being partially filled with water, only small quantities of coal were taken out from time to time for gas manufacturing at Greensboro, until 1887, when the present owners took possession of the property, since which time the machine plant has been renewed, water removed, the shaft (which had caved in) restored, platform chutes erected for handling, loading, and storing coal, and 1 mile of standard-gauge railway constructed to connect with the Cape Fear and Yadkin Valley railroad.

The coal product of 3 counties in Georgia and North Carolina, namely, Dade county, Georgia, and Chatham and Stokes counties, North Carolina, in 1889 was as follows:

| | SHORT TONS. |
|---|---|
| Loaded at mines for shipment on railroad cars and boats | 46,321 |
| Sold to local trade at mines | 31 |
| Used by employés | 158 |
| Used for steam at mines | 15,001 |
| Manufactured into coke | 164,645 |
| Total | 226,156 |

The amount received for coal sold in the year 1889 was $339,382, and the average price at the mines per ton of 2,000 pounds was $1.50.

The total number of employés in 1889 in these states, including office force, was 740, to whom was paid in wages $265,464. The expenditures were as follows:

| | |
|---|---|
| For wages | $265,464 |
| For supplies and materials of all kinds | 102,655 |
| All other expenditures for mines or works | 6,546 |
| For contract work | 51,400 |
| Total | 426,065 |

The number of acres owned in these counties was 20,733, and the value of mines and improvements was as follows:

| | |
|---|---|
| In land | $348,300 |
| In buildings and fixtures | 58,000 |
| In tools, implements, live stock, machinery, and supplies | 283,000 |
| Cash capital | 35,200 |
| Total | 724,500 |

The total number of employés about mines in Georgia and North Carolina was 733, and the total amount paid in wages was $258,016. The following table gives the different classes employed above and below ground:

EMPLOYÉS AT GEORGIA AND NORTH CAROLINA COAL MINES IN 1889.

| CLASSIFICATION OF EMPLOYÉS. | Average number employed. | Average wages per day. | Average number of days worked. |
|---|---|---|---|
| ABOVE GROUND. | | | |
| Foremen or overseers | 12 | $2.29 | 264 |
| Mechanics | 34 | 2.15 | 210 |
| Laborers | 277 | 0.96 | 255 |
| Boys under 16 years | 6 | 0.45 | 24 |
| Total | 329 | | |
| BELOW GROUND. | | | |
| Foremen or overseers | 13 | 1.64 | 210 |
| Miners | 271 | 1.46 | 291 |
| Laborers | 120 | 0.98 | 288 |
| Total | 404 | | |

## ILLINOIS.

The state of Illinois contains much the larger portion of what is known as the Central coal field, covering an area of about 37,000 square miles and underlying 60 counties, in but 45 of which, however, are operations conducted upon a commercial scale. The Illinois field contains 15 distinct seams. Those which are available for commercial mining generally lie at considerable depth, and are reached by shafts. The coals of Illinois are bituminous, and furnish a most excellent steaming fuel. Coke is manufactured to a limited extent in Gallatin and Lasalle counties, but elsewhere in the state the coal does not yield a marketable coke. Neither is it in any marked degree a good gas coal, although it is used for that purpose in some localities, rather because of its abundance than special adaptability; but it is thought that the increasing facilities for the cheap transportation of Pittsburg coal into the state will eventually exclude local coal from the manufacture of gas.

The total product of the state during the year ended June 30, 1880, as reported to the census, was 6,115,377 short tons, valued at $8,779,832, an average of $1.44 per ton, at the mines. The product during the year 1889 was 12,104,272 short tons, valued at $11,755,203, an average of $0.97 per ton, at the mines. The product reported by the state authorities for the year ended June 30, 1889, was 13,105,698 short tons. The falling off in production for 1889, as shown by the present report, is mainly due to an extensive strike of the miners in the northern districts of the state during 6 months of the year, but also in some measure to depression in the trade, resulting from the mild winter of 1888–1889.

The following table gives the total production of coal in 1889 and the disposition of the same:

### COAL PRODUCT OF ILLINOIS FOR 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | MINES. | | Total product of coal of all grades for 1889. | DISPOSITION OF TOTAL PRODUCT. | | | | | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Regular. | Local. | | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | Manufactured into coke. | | |
| Total | 358 | 714 | 12,104,272 | 9,884,883 | 1,699,478 | 111,224 | 395,787 | 12,900 | $11,755,203 | $0.97 |
| Adams | | 5 | 294 | | 294 | | | | 730 | 2.48 |
| Bond | 2 | | 62,923 | 50,510 | 9,000 | 413 | 3,000 | | 58,783 | 0.93 |
| Brown | | 1 | 60 | | 60 | | | | 90 | 1.50 |
| Bureau | 9 | 11 | 342,573 | 270,535 | 44,103 | 790 | 27,145 | | 441,360 | 1.29 |
| Calhoun | | 1 | 981 | | 967 | 14 | | | 1,226 | 1.25 |
| Cass | 1 | 3 | 3,373 | 33 | 3,114 | 40 | 186 | | 5,702 | 1.69 |
| Christian | 5 | | 136,658 | 109,361 | 19,452 | 1,159 | 6,686 | | 106,745 | 0.78 |
| Clinton | 3 | | 156,040 | 136,417 | 6,850 | 1,062 | 11,711 | | 128,957 | 0.83 |
| Crawford | | 1 | 110 | | 100 | 10 | | | 220 | 2.00 |
| Effingham | | 4 | 775 | | 770 | 5 | | | 1,170 | 1.51 |
| Franklin | | 1 | 700 | | 700 | | | | 1,050 | 1.50 |
| Fulton | 24 | 96 | 466,383 | 382,618 | 67,743 | 4,070 | 11,952 | | 503,912 | 1.08 |
| Gallatin | 2 | 6 | 54,343 | 40,008 | 2,455 | 232 | 448 | 11,200 | 38,732 | 0.71 |
| Greene | 2 | 15 | 14,969 | 1,880 | 12,912 | 169 | 8 | | 24,436 | 1.63 |
| Grundy | 11 | 11 | 554,595 | 524,412 | 23,083 | 6,148 | 952 | | 778,752 | 1.40 |
| Hamilton | | 1 | 450 | | 450 | | | | 675 | 1.50 |
| Hancock | | 7 | 5,249 | | 5,170 | 79 | | | 8,025 | 1.53 |
| Hardin | | 1 | 40 | | 40 | | | | 50 | 1.25 |
| Henry | 10 | 22 | 112,542 | 70,383 | 37,727 | 1,276 | 3,156 | | 159,978 | 1.42 |
| Jackson | 9 | 16 | 513,634 | 453,176 | 37,496 | 5,939 | 17,023 | | 474,933 | 0.92 |
| Jasper | | 1 | 100 | | 100 | | | | 200 | 2.00 |
| Jefferson | | 5 | 1,950 | | 1,775 | 55 | 120 | | 2,925 | 1.50 |
| Jersey | | 4 | 1,104 | | 1,086 | 17 | 1 | | 1,669 | 1.51 |
| Johnson | 1 | 3 | 3,510 | 3,000 | 410 | 100 | | | 3,020 | 0.86 |
| Kankakee | 1 | 1 | 55,286 | 51,331 | 2,285 | 900 | 770 | | 78,588 | 1.42 |
| Knox | 2 | 50 | 46,799 | | 46,150 | 629 | 20 | | 58,546 | 1.25 |
| Lasalle | 21 | 8 | 973,832 | 749,782 | 176,603 | 15,563 | 30,184 | 1,700 | 1,118,631 | 1.15 |
| Livingston | 10 | 3 | 338,089 | 276,557 | 49,029 | 3,511 | 8,992 | | 376,747 | 1.11 |
| Logan | 3 | | 154,602 | 105,688 | 35,317 | 9,337 | 4,260 | | 174,531 | 1.13 |
| McDonough | 6 | 56 | 96,336 | 66,660 | 26,603 | 1,197 | 1,876 | | 154,549 | 1.60 |
| McLean | 3 | | 169,134 | 117,897 | 40,157 | 3,530 | 7,550 | | 216,535 | 1.28 |
| Macon | 2 | | 196,550 | 103,420 | 92,365 | 390 | 375 | | 229,131 | 1.17 |
| Macoupin | 15 | 8 | 1,339,112 | 1,237,656 | 51,164 | 6,072 | 44,220 | | 973,487 | 0.73 |
| Madison | 10 | 16 | 576,996 | 468,689 | 75,900 | 3,924 | 28,483 | | 438,361 | 0.76 |
| Marion | 5 | | 220,819 | 198,582 | 10,995 | 2,967 | 8,275 | | 176,982 | 0.80 |
| Marshall | 2 | 12 | 51,762 | 35,855 | 10,130 | 977 | 4,800 | | 63,890 | 1.23 |
| Menard | 6 | 6 | 255,050 | 202,603 | 42,873 | 1,024 | 8,550 | | 238,861 | 0.94 |
| Mercer | 4 | 20 | 262,173 | 232,969 | 19,955 | 2,861 | 6,388 | | 295,132 | 1.13 |
| Montgomery | 3 | | 33,248 | 19,078 | 12,930 | 40 | 1,200 | | 33,479 | 1.01 |
| Morgan | 1 | 4 | 20,556 | | 19,805 | 323 | 428 | | 30,963 | 1.51 |
| Peoria | 35 | 70 | 588,800 | 446,371 | 128,709 | 4,482 | 9,238 | | 597,449 | 1.01 |
| Perry | 14 | 6 | 492,555 | 436,288 | 22,983 | 6,144 | 27,140 | | 400,126 | 0.81 |
| Pike | | 8 | 102 | | 85 | 17 | | | 198 | 1.94 |
| Randolph | 9 | 9 | 111,365 | 93,022 | 16,409 | 612 | 1,322 | | 86,446 | 0.78 |
| Richland | | 6 | 140 | | 113 | 27 | | | 280 | 2.00 |
| Rock Island | 5 | 21 | 59,127 | 13,324 | 43,922 | 601 | 1,280 | | 79,023 | 1.34 |
| Saint Clair | 58 | 24 | 1,269,366 | 1,099,564 | 125,269 | 1,904 | 42,629 | | 840,393 | 0.66 |
| Saline | 4 | 13 | 37,095 | 29,032 | 6,505 | 708 | 850 | | 32,724 | 0.88 |
| Sangamon | 17 | | 894,703 | 722,234 | 134,112 | 9,289 | 29,068 | | 783,279 | 0.88 |
| Schuyler | 3 | 5 | 29,694 | 19,656 | 4,280 | 59 | 5,699 | | 25,963 | 0.87 |
| Scott | 1 | 9 | 16,739 | 13,000 | 3,090 | 547 | 102 | | 25,203 | 1.51 |
| Shelby | 1 | 7 | 11,750 | | 11,703 | 47 | | | 20,155 | 1.72 |
| Stark | 1 | 28 | 21,568 | 200 | 21,203 | 159 | 6 | | 31,310 | 1.45 |
| Tazewell | 5 | 6 | 68,019 | 50,906 | 14,806 | 582 | 1,725 | | 74,173 | 1.09 |
| Vermilion | 22 | 57 | 593,208 | 494,915 | 88,917 | 2,185 | 7,191 | | 606,598 | 1.02 |
| Warren | | 31 | 16,104 | | 15,992 | 101 | 11 | | 30,378 | 1.89 |
| Washington | 2 | 2 | 34,917 | 26,183 | 7,031 | 136 | 1,567 | | 32,538 | 0.93 |
| Will | 3 | 1 | 301,638 | 276,568 | 5,960 | 5,590 | 13,520 | | 353,483 | 1.17 |
| Williamson | 3 | 12 | 193,159 | 175,139 | 12,253 | 1,087 | 4,680 | | 138,797 | 0.72 |
| Woodford | 2 | | 140,523 | 79,381 | 48,018 | 2,124 | 11,000 | | 194,934 | 1.39 |

The following table shows the labor employed at the mines, both above and below ground, the average wages paid per day, and the total amount of wages paid in 1889:

LABOR AND WAGES AT ILLINOIS COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mines. | ABOVE GROUND. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Total | 23,934 | 2,584 | 217 | $2.33 | 262 | 625 | $2.02 | 266 | 1,678 | $1.52 | 201 | 64 | $0.80 | 200 |
| Bond | 95 | 20 | 1 | 2.50 | 365 | 4 | 1.88 | 225 | 14 | 1.61 | 250 | 1 | 1.00 | 300 |
| Bureau | 1,438 | 131 | 7 | 2.52 | 211 | 24 | 2.17 | 351 | 94 | 1.51 | 106 | 6 | 0.75 | 115 |
| Cass | 12 | 3 | 1 | 1.35 | 40 | 1 | 2.25 | 53 | 1 | 1.50 | 57 | | | |
| Christian | 271 | 48 | 5 | 3.50 | 234 | 15 | 2.00 | 241 | 28 | 1.47 | 218 | | | |
| Clinton | 243 | 40 | | | | 14 | 1.88 | 272 | 26 | 1.48 | 217 | | | |
| Fulton | 819 | 98 | 6 | 2.52 | 297 | 20 | 1.76 | 259 | 69 | 1.54 | 220 | 3 | 0.67 | 231 |
| Gallatin | 71 | 9 | 2 | 2.12 | 237 | 2 | 1.50 | 237 | 4 | 1.25 | 257 | 1 | 0.50 | 164 |
| Greene | 13 | 4 | 1 | 2.00 | 89 | 1 | 1.00 | 150 | 2 | 1.38 | 250 | | | |
| Grundy | 2,199 | 163 | 12 | 2.28 | 275 | 33 | 2.14 | 232 | 112 | 1.62 | 204 | 6 | 1.02 | 171 |
| Henry | 256 | 33 | 4 | 2.18 | 300 | 8 | 1.82 | 280 | 21 | 1.47 | 247 | | | |
| Jackson | 753 | 98 | 10 | 2.28 | 290 | 27 | 1.98 | 264 | 57 | 1.50 | 224 | 4 | 0.59 | 191 |
| Johnson | 14 | 2 | | | | | | | 2 | 1.00 | 84 | | | |
| Kankakee | 285 | 20 | 1 | 1.80 | 312 | 4 | 2.12 | 280 | 15 | 1.50 | 164 | | | |
| Knox | 21 | | | | | | | | | | | | | |
| Lasalle | 3,099 | 268 | 15 | 2.14 | 234 | 51 | 2.12 | 270 | 195 | 1.61 | 137 | 7 | 0.89 | 157 |
| Livingston | 1,015 | 84 | 8 | 2.41 | 231 | 15 | 2.00 | 286 | 59 | 1.72 | 162 | 2 | 2.00 | 20 |
| Logan | 281 | 32 | 2 | 3.25 | 307 | 6 | 1.96 | 304 | 24 | 1.46 | 263 | | | |
| McDonough | 266 | 19 | 2 | 2.15 | 306 | 5 | 1.98 | 220 | 12 | 1.83 | 180 | | | |
| McLean | 365 | 22 | 3 | 3.33 | 309 | 7 | 2.07 | 302 | 12 | 1.58 | 214 | | | |
| Macon | 351 | 33 | 3 | 3.90 | 348 | 9 | 2.18 | 309 | 20 | 1.50 | 278 | 1 | 1.00 | 235 |
| Macoupin | 1,483 | 159 | 12 | 2.11 | 287 | 41 | 2.27 | 290 | 104 | 1.64 | 259 | 2 | 0.84 | 249 |
| Madison | 686 | 96 | 4 | 2.34 | 284 | 23 | 2.13 | 308 | 61 | 1.62 | 221 | 8 | 0.66 | 238 |
| Marion | 404 | 71 | 4 | 2.30 | 303 | 10 | 1.67 | 302 | 55 | 1.11 | 238 | 2 | 0.75 | 244 |
| Marshall | 246 | 16 | 2 | 3.00 | 275 | 5 | 2.35 | 270 | 9 | 1.50 | 130 | | | |
| Menard | 337 | 48 | 5 | 2.53 | 273 | 14 | 2.16 | 264 | 29 | 1.56 | 238 | | | |
| Mercer | 466 | 41 | 4 | 2.50 | 303 | 9 | 2.33 | 304 | 28 | 1.68 | 192 | | | |
| Montgomery | 116 | 19 | 2 | 2.25 | 300 | 8 | 2.00 | 289 | 9 | 1.44 | 271 | | | |
| Morgan | 45 | 6 | 1 | 3.30 | 365 | 2 | 2.00 | 270 | 3 | 1.50 | 210 | | | |
| Peoria | 980 | 126 | 15 | 1.95 | 193 | 30 | 1.86 | 226 | 75 | 1.51 | 196 | 6 | 0.76 | 281 |
| Perry | 908 | 104 | 9 | 1.81 | 245 | 22 | 1.78 | 219 | 73 | 1.28 | 204 | | | |
| Randolph | 249 | 41 | 8 | 1.74 | 208 | 13 | 1.41 | 208 | 18 | 1.34 | 212 | 2 | 1.00 | 250 |
| Rock Island | 94 | 14 | 4 | 1.83 | 258 | 3 | 2.03 | 209 | 6 | 1.41 | 222 | 1 | 0.75 | 100 |
| Saint Clair | 1,579 | 208 | 18 | 1.95 | 281 | 69 | 1.89 | 259 | 115 | 1.64 | 217 | 6 | 0.75 | 215 |
| Saline | 98 | 14 | 2 | 1.50 | 150 | 2 | 1.50 | 308 | 10 | 1.08 | 175 | | | |
| Sangamon | 1,385 | 156 | 14 | 2.88 | 278 | 45 | 2.23 | 276 | 94 | 1.61 | 220 | 3 | 1.00 | 257 |
| Schuyler | 49 | 10 | 3 | 1.00 | 240 | 4 | 1.07 | 271 | 3 | 1.25 | 200 | | | |
| Scott | 40 | 3 | 1 | 3.00 | 300 | | | | 2 | 1.25 | 300 | | | |
| Shelby | 12 | 1 | | | | | | | 1 | 1.25 | 250 | | | |
| Stark | 4 | 1 | | | | | | | 1 | 1.50 | 150 | | | |
| Tazewell | 115 | 20 | 3 | 2.17 | 309 | 8 | 1.67 | 293 | 9 | 1.50 | 239 | | | |
| Vermilion | 974 | 144 | 13 | 2.21 | 289 | 35 | 2.09 | 273 | 94 | 1.44 | 234 | 2 | 0.88 | 185 |
| Washington | 63 | 8 | | | | 3 | 1.67 | 304 | 5 | 1.25 | 255 | | | |
| Will | 1,152 | 67 | 5 | 1.85 | 210 | 16 | 2.14 | 201 | 46 | 1.55 | 139 | | | |
| Williamson | 229 | 30 | 2 | 3.17 | 287 | 5 | 2.00 | 247 | 22 | 1.34 | 197 | 1 | 0.50 | 161 |
| Woodford | 353 | 54 | 3 | 3.33 | 308 | 12 | 2.00 | 275 | 39 | 1.42 | 242 | | | |

LABOR AND WAGES AT ILLINOIS COAL MINES IN 1889, BY COUNTIES—Continued.

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Total | 21,350 | 305 | $2.38 | 256 | 15,386 | $1.98 | 177 | 5,062 | $1.76 | 199 | 597 | $0.89 | 176 | $8,429,573 |
| Bond | 75 | 2 | 2.25 | 257 | 61 | 2.13 | 230 | 11 | 1.84 | 236 | 1 | 1.00 | 300 | 44,848 |
| Bureau | 1,307 | 7 | 2.39 | 201 | 945 | 2.03 | 125 | 326 | 1.85 | 132 | 29 | 0.76 | 115 | 362,082 |
| Cass | 9 | 1 | 2.25 | 53 | 4 | 2.00 | 49 | 4 | 2.00 | 51 | | | | 1,188 |
| Christian | 223 | 4 | 2.23 | 193 | 189 | 1.77 | 196 | 27 | 1.76 | 201 | 3 | 0.70 | 150 | 95,859 |
| Clinton | 203 | 3 | 2.80 | 313 | 30 | 1.35 | 208 | 167 | 1.85 | 223 | 3 | 0.50 | 126 | 97,066 |
| Fulton | 721 | 17 | 2.20 | 256 | 602 | 2.19 | 193 | 89 | 1.67 | 215 | 13 | 0.98 | 184 | 329,445 |
| Gallatin | 62 | 2 | 2.12 | 240 | 49 | 1.83 | 190 | 11 | 1.28 | 248 | | | | 28,445 |
| Greene | 9 | | | | 9 | 1.83 | 217 | | | | | | | 4,917 |
| Grundy | 2,036 | 14 | 2.74 | 299 | 1,645 | 2.17 | 145 | 302 | 1.67 | 150 | 75 | 1.10 | 135 | 660,466 |
| Henry | 223 | 6 | 1.97 | 207 | 201 | 1.54 | 211 | 15 | 1.60 | 253 | 1 | 1.00 | 270 | 90,602 |
| Jackson | 655 | 10 | 2.44 | 270 | 491 | 1.84 | 222 | 137 | 1.76 | 166 | 17 | 0.70 | 212 | 305,420 |
| Johnson | 12 | 1 | 1.60 | 84 | 7 | 1.10 | 84 | 2 | 1.50 | 50 | 2 | 0.75 | 50 | 1,174 |
| Kankakee | 265 | 1 | 3.20 | 365 | 230 | 1.85 | 121 | 29 | 1.90 | 200 | 5 | 0.85 | 121 | 71,205 |
| Knox | 21 | 1 | 1.50 | 300 | 20 | 1.88 | 142 | | | | | | | 4,263 |
| Lasalle | 2,831 | 22 | 2.57 | 253 | 2,204 | 2.22 | 127 | 510 | 1.83 | 146 | 95 | 0.92 | 128 | 866,677 |
| Livingston | 931 | 10 | 2.32 | 245 | 770 | 2.07 | 131 | 134 | 1.82 | 140 | 17 | 0.79 | 126 | 277,240 |
| Logan | 249 | 4 | 2.33 | 303 | 190 | 2.07 | 215 | 48 | 1.60 | 260 | 7 | 0.75 | 200 | 125,603 |
| McDonough | 247 | 4 | 2.45 | 309 | 190 | 1.85 | 190 | 25 | 1.50 | 200 | 28 | 0.96 | 189 | 91,096 |
| McLean | 343 | 4 | 2.78 | 310 | 282 | 1.64 | 254 | 50 | 1.77 | 265 | 7 | 1.00 | 250 | 156,383 |
| Macon | 318 | 2 | 2.50 | 365 | 230 | 1.74 | 284 | 75 | 1.52 | 297 | 11 | 0.80 | 294 | 168,838 |
| Macoupin | 1,324 | 16 | 2.68 | 291 | 403 | 1.76 | 245 | 840 | 1.83 | 245 | 65 | 0.98 | 247 | 658,701 |
| Madison | 590 | 12 | 2.43 | 281 | 181 | 2.24 | 178 | 365 | 1.86 | 239 | 32 | 0.67 | 220 | 288,971 |
| Marion | 333 | 5 | 2.05 | 237 | 254 | 1.62 | 207 | 66 | 1.53 | 232 | 8 | 0.65 | 210 | 134,181 |
| Marshall | 230 | 2 | 2.63 | 232 | 200 | 1.79 | 109 | 28 | 1.80 | 120 | | | | 50,030 |
| Menard | 289 | 6 | 2.42 | 273 | 216 | 2.18 | 232 | 65 | 1.80 | 233 | 2 | 0.60 | 190 | 162,123 |
| Mercer | 425 | 4 | 3.25 | 313 | 273 | 3.15 | 196 | 142 | 1.96 | 204 | 6 | 1.25 | 164 | 233,569 |
| Montgomery | 97 | 3 | 2.00 | 320 | 79 | 1.72 | 164 | 15 | 1.47 | 232 | | | | 37,570 |
| Morgan | 39 | 1 | 2.25 | 280 | 30 | 2.00 | 243 | 7 | 1.50 | 273 | 1 | 1.00 | 62 | 21,368 |
| Peoria | 854 | 27 | 1.97 | 235 | 702 | 2.08 | 194 | 100 | 1.65 | 211 | 25 | 0.94 | 181 | 374,950 |
| Perry | 804 | 13 | 2.39 | 257 | 614 | 1.80 | 205 | 145 | 1.50 | 207 | 32 | 0.53 | 219 | 316,551 |
| Randolph | 208 | 8 | 2.15 | 202 | 141 | 1.66 | 165 | 55 | 1.46 | 183 | 4 | 0.75 | 145 | 66,638 |
| Rock Island | 80 | 4 | 2.19 | 212 | 71 | 1.86 | 167 | 5 | 1.59 | 123 | | | | 29,833 |
| Saint Clair | 1,371 | 39 | 2.25 | 237 | 727 | 1.70 | 212 | 590 | 1.80 | 193 | 15 | 0.78 | 224 | 574,835 |
| Saline | 84 | 4 | 1.63 | 262 | 74 | 1.39 | 148 | 5 | 1.35 | 130 | 1 | 0.50 | 200 | 23,390 |
| Sangamon | 1,229 | 15 | 2.69 | 284 | 936 | 2.14 | 221 | 258 | 1.75 | 214 | 20 | 1.03 | 230 | 634,931 |
| Schuyler | 39 | 3 | 1.83 | 260 | 34 | 1.61 | 202 | 2 | 1.25 | 220 | | | | 15,434 |
| Scott | 37 | | | | 35 | 1.50 | 250 | 2 | 1.25 | 300 | | | | 14.775 |
| Shelby | 11 | | | | 10 | 2.00 | 250 | 1 | 1.50 | 250 | | | | 5,688 |
| Stark | 3 | | | | 3 | 1.50 | 150 | | | | | | | 750 |
| Tazewell | 95 | 5 | 2.05 | 284 | 80 | 1.87 | 230 | 7 | 1.74 | 221 | 3 | 1.00 | 223 | 48,833 |
| Vermilion | 830 | 13 | 2.07 | 231 | 684 | 1.83 | 232 | 115 | 1.58 | 235 | 18 | 0.78 | 118 | 395,803 |
| Washington | 55 | 1 | 2.00 | 313 | 45 | 1.58 | 264 | 9 | 1.42 | 256 | | | | 25,462 |
| Will | 1,085 | 5 | 3.00 | 240 | 926 | 1.99 | 138 | 128 | 1.66 | 139 | 26 | 1.15 | 138 | 311,217 |
| Williamson | 199 | 1 | 2.70 | 191 | 84 | 1.87 | 249 | 98 | 1.75 | 181 | 16 | 0.72 | 204 | 83,363 |
| Woodford | 299 | 3 | 3.00 | 308 | 235 | 1.67 | 231 | 52 | 1.68 | 236 | 9 | 1.25 | 190 | 137,769 |

The following table shows the office force employed and the amount expended in coal-mining operations during the year 1889:

## EXPENDITURES AT ILLINOIS COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| Total | 389 | $264,794 | 374 | $260,104 | 15 | $4,690 | 24,323 | $8,694,347 | $966,927 | $678,133 | $10,339,407 | $26,662 | $10,366,069 |
| Bond | 2 | 1,200 | 2 | 1,200 | ...... | .......... | 97 | 46,048 | 4,626 | 888 | 51,562 | .......... | 51,562 |
| Bureau | 18 | 16,504 | 17 | 16,204 | 1 | 300 | 1,456 | 378,587 | 57,206 | 43,214 | 479,007 | .......... | 479,007 |
| Cass and Christian | 8 | 4,228 | 8 | 4,228 | ...... | .......... | 291 | 101,275 | 7,721 | 11,913 | 120,909 | 407 | 121,316 |
| Clinton | 3 | 2,064 | 3 | 2,064 | ...... | .......... | 246 | 99,130 | 26,196 | 6,937 | 132,263 | 2,000 | 134,263 |
| Fulton | 17 | 9,760 | 17 | 9,760 | ...... | .......... | 836 | 339,205 | 38,385 | 23,805 | 401,395 | 2,400 | 403,795 |
| Gallatin | 3 | 2,820 | 3 | 2,820 | ...... | .......... | 74 | 31,265 | 1,954 | 980 | 34,199 | .......... | 34,199 |
| Greene | 1 | 600 | 1 | 600 | ...... | .......... | 14 | 5,517 | 295 | 627 | 6,439 | .......... | 6,439 |
| Grundy | 13 | 10,994 | 13 | 10,994 | ...... | .......... | 2,212 | 671,460 | 65,267 | 38,107 | 774,834 | .......... | 774,834 |
| Henry | 9 | 7,876 | 9 | 7,876 | ...... | .......... | 265 | 98,478 | 5,074 | 7,168 | 110,720 | 117 | 110,837 |
| Jackson | 13 | 10,597 | 12 | 10,417 | 1 | 180 | 766 | 316,017 | 48,529 | 37,064 | 401,610 | .......... | 401,610 |
| Johnson and Kankakee | 2 | 734 | 2 | 734 | ...... | .......... | 301 | 73,113 | 4,518 | 1,238 | 78,869 | .......... | 78,869 |
| Knox | ...... | .......... | ...... | .......... | ...... | .......... | 21 | 4,263 | 450 | 1,000 | 5,713 | .......... | 5,713 |
| Lasalle | 38 | 28,342 | 35 | 27,529 | 3 | 813 | 3,137 | 895,019 | 84,369 | 38,023 | 1,017,411 | .......... | 1,017,411 |
| Livingston | 19 | 12,766 | 18 | 12,679 | 1 | 87 | 1,034 | 290,006 | 20,982 | 10,977 | 321,965 | 150 | 322,115 |
| Logan | 5 | 3,300 | 5 | 3,300 | ...... | .......... | 286 | 128,903 | 13,186 | 8,350 | 150,439 | 5,500 | 155,939 |
| McDonough | 2 | 1,320 | 2 | 1,320 | ...... | .......... | 268 | 92,416 | 7,200 | 1,470 | 101,086 | .......... | 101,086 |
| McLean | 7 | 5,456 | 6 | 4,856 | 1 | 600 | 372 | 161,839 | 20,700 | 2,100 | 184,639 | 2,000 | 186,639 |
| Macon | 6 | 4,760 | 6 | 4,760 | ...... | .......... | 357 | 173,598 | 16,837 | 21,538 | 211,973 | .......... | 211,973 |
| Macoupin | 20 | 19,633 | 19 | 19,033 | 1 | 600 | 1,503 | 678,334 | 86,315 | 60,572 | 825,221 | .......... | 825,221 |
| Madison | 11 | 6,638 | 11 | 6,638 | ...... | .......... | 697 | 295,609 | 35,710 | 22,912 | 354,231 | .......... | 354,231 |
| Marion | 14 | 7,820 | 14 | 7,820 | ...... | .......... | 418 | 142,001 | 15,127 | 8,894 | 166,022 | .......... | 166,022 |
| Marshall | 5 | 4,773 | 5 | 4,773 | ...... | .......... | 251 | 54,803 | 8,621 | 7,300 | 70,724 | 1,100 | 71,824 |
| Menard | 7 | 4,840 | 7 | 4,840 | ...... | .......... | 344 | 166,963 | 25,345 | 8,683 | 200,991 | .......... | 200,991 |
| Mercer | 3 | 3,300 | 3 | 3,300 | ...... | .......... | 469 | 236,869 | 28,944 | 55,730 | 321,543 | .......... | 321,543 |
| Montgomery | 2 | 840 | 2 | 840 | ...... | .......... | 118 | 38,410 | 2,852 | 1,753 | 43,015 | 506 | 43,521 |
| Morgan | 2 | 1,200 | 2 | 1,200 | ...... | .......... | 47 | 22,568 | 1,262 | 362 | 24,192 | .......... | 24,192 |
| Peoria | 22 | 10,831 | 21 | 10,471 | 1 | 360 | 1,002 | 385,781 | 62,416 | 28,445 | 476,642 | 993 | 477,635 |
| Perry | 19 | 11,231 | 18 | 10,931 | 1 | 300 | 927 | 327,782 | 37,945 | 12,231 | 377,958 | 500 | 378,458 |
| Randolph | 5 | 3,160 | 5 | 3,160 | ...... | .......... | 254 | 69,798 | 7,542 | 2,867 | 80,207 | .......... | 80,207 |
| Rock Island | 2 | 640 | 2 | 640 | ...... | .......... | 96 | 30,473 | 1,916 | 2,555 | 34,944 | 13 | 34,957 |
| Saint Clair | 31 | 13,131 | 31 | 13,131 | ...... | .......... | 1,610 | 587,966 | 77,955 | 78,635 | 744,556 | 5,495 | 750,051 |
| Saline | 3 | 1,230 | 3 | 1,230 | ...... | .......... | 101 | 24,620 | 2,205 | 882 | 27,707 | 460 | 28,167 |
| Sangamon | 28 | 23,608 | 28 | 23,608 | ...... | .......... | 1,413 | 658,539 | 68,571 | 39,702 | 766,812 | .......... | 766,812 |
| Schuyler | 1 | 480 | 1 | 480 | ...... | .......... | 50 | 15,914 | 2,400 | 3,045 | 21,359 | .......... | 21,359 |
| Scott, Shelby, and Stark | 2 | 1,200 | 2 | 1,200 | ...... | .......... | 58 | 22,413 | 1,625 | 1,181 | 25,219 | .......... | 25,219 |
| Tazewell | 3 | 1,450 | 2 | 1,200 | 1 | 250 | 118 | 50,283 | 6,880 | 3,602 | 60,765 | 500 | 61,265 |
| Vermilion | 9 | 6,293 | 8 | 5,993 | 1 | 300 | 983 | 402,096 | 37,219 | 39,018 | 478,333 | 3,321 | 481,654 |
| Washington | 1 | 300 | 1 | 300 | ...... | .......... | 64 | 25,762 | 500 | 2,945 | 29,207 | .......... | 29,207 |
| Will | 23 | 10,215 | 20 | 9,315 | 3 | 900 | 1,175 | 321,432 | 10,600 | 29,048 | 361,080 | 200 | 361,280 |
| Williamson | 5 | 5,040 | 5 | 5,040 | ...... | .......... | 234 | 88,403 | 15,982 | 7,610 | 111,995 | .......... | 111,995 |
| Woodford | 5 | 3,620 | 5 | 3,620 | ...... | .......... | 358 | 141,389 | 5,500 | 4,762 | 151,651 | 1,000 | 152,651 |

The following table gives the value of Illinois mines and improvements and the number of animals employed therein:

VALUE OF ILLINOIS COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | | | Number of animals employed. |
|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | |
| | Acres. | Value. | Acres. | Value. | | | | | | |
| Total | 161, 468 | $8, 074, 020 | 30, 272 | $1, 816, 644 | $3, 923, 747 | $2, 325, 547 | $16, 139, 958 | $1, 490, 393 | $17, 630, 351 | 2, 230 |
| Bond | 1, 300 | 26, 000 | 529 | 18, 040 | 7, 000 | 11, 000 | 62, 040 | 5, 700 | 67, 740 | 8 |
| Bureau | 36, 994 | 2, 500, 342 | 1, 460 | 98, 000 | 509, 977 | 37, 239 | 3, 145, 558 | 157, 000 | 3, 302, 558 | 103 |
| Cass and Christian | 2, 364 | 70, 225 | 674 | 41, 210 | 200, 016 | 71, 525 | 382, 976 | 14, 713 | 397, 689 | 19 |
| Clinton | 1, 540 | 65, 810 | | | 58, 250 | 13, 882 | 137, 942 | 14, 150 | 152, 092 | 21 |
| Fulton | 718 | 43, 555 | 2, 177 | 116, 036 | 107, 517 | 101, 538 | 362, 646 | 48, 650 | 411, 296 | 75 |
| Gallatin | 2, 000 | 20, 000 | 100 | 3, 000 | 2, 500 | 3, 115 | 28, 615 | 2, 500 | 31, 115 | 10 |
| Greene | 80 | 8, 000 | 160 | 8, 000 | 4, 200 | 600 | 20, 800 | 750 | 21, 550 | 10 |
| Grundy | 10, 847 | 855, 441 | 160 | 3, 200 | 173, 896 | 287, 192 | 1, 319, 729 | 106, 700 | 1, 426, 429 | 194 |
| Henry | 1, 213 | 79, 400 | 354 | 18, 782 | 14, 585 | 17, 474 | 130, 241 | 14, 050 | 144, 291 | 11 |
| Jackson | 46, 547 | 956, 300 | 320 | 12, 800 | 102, 775 | 90, 320 | 1, 162, 195 | 45, 700 | 1, 207, 895 | 107 |
| Johnson and Kankakee | 284 | 17, 500 | 240 | 12, 000 | 23, 900 | 23, 815 | 77, 215 | 5, 700 | 82, 915 | 29 |
| Knox | | | 270 | 11, 300 | 650 | 650 | 12, 600 | 500 | 13, 100 | 2 |
| Lasalle | 14, 858 | 1, 253, 946 | 205 | 13, 000 | 382, 125 | 214, 456 | 1, 863, 527 | 183, 770 | 2, 047, 297 | 280 |
| Livingston | 1, 211 | 153, 625 | 9 | 850 | 73, 892 | 30, 138 | 258, 505 | 54, 200 | 312, 705 | 65 |
| Logan | 280 | 28, 000 | 1, 350 | 35, 000 | 76, 000 | 25, 600 | 164, 600 | 17, 500 | 182, 100 | 22 |
| McDonough | 1, 049 | 53, 475 | | | 8, 375 | 12, 065 | 73, 915 | 12, 575 | 86, 490 | 27 |
| McLean | 100 | 20, 000 | 680 | 42, 400 | 59, 800 | 85, 500 | 207, 700 | 16, 100 | 223, 800 | 16 |
| Macon | 6 | 1, 000 | 560 | 28, 000 | 37, 000 | 70, 000 | 136, 000 | 20, 000 | 156, 000 | 36 |
| Macoupin | 8, 814 | 195, 375 | 391 | 7, 820 | 372, 901 | 131, 650 | 707, 746 | 97, 700 | 805, 446 | 133 |
| Madison | 1, 528 | 77, 925 | 770 | 32, 410 | 153, 800 | 85, 250 | 349, 385 | 40, 400 | 389, 785 | 61 |
| Marion | 869 | 31, 285 | 160 | 8, 000 | 63, 852 | 35, 517 | 138, 654 | 17, 550 | 156, 204 | 64 |
| Marshall | 205 | 5, 000 | 1, 720 | 78, 000 | 34, 000 | 13, 000 | 130, 000 | 15, 000 | 145, 000 | 13 |
| Menard | 165 | 16, 600 | 1, 380 | 174, 000 | 17, 300 | 52, 960 | 260, 860 | 22, 700 | 283, 560 | 34 |
| Mercer | 2, 118 | 118, 840 | | | 78, 600 | 38, 800 | 236, 240 | 65, 750 | 301, 990 | 67 |
| Montgomery | 622 | 6, 350 | | | 26, 665 | 13, 985 | 47, 000 | 13, 200 | 60, 200 | 7 |
| Morgan | 3 | 1, 200 | | | 12, 000 | 9, 600 | 22, 800 | 2, 000 | 24, 800 | 3 |
| Peoria | 5, 249 | 286, 300 | 2, 861 | 177, 300 | 88, 342 | 116, 111 | 668, 053 | 57, 550 | 725, 603 | 89 |
| Perry | 3, 197 | 97, 500 | 562 | 46, 000 | 94, 692 | 78, 214 | 316, 406 | 45, 361 | 361, 767 | 134 |
| Randolph | 500 | 26, 200 | 1, 228 | 31, 580 | 24, 740 | 39, 166 | 121, 686 | 12, 050 | 133, 736 | 20 |
| Rock Island | 40 | 7, 000 | 800 | 28, 000 | 14, 100 | 7, 900 | 57, 000 | 3, 975 | 60, 975 | 8 |
| Saint Clair | 3, 408 | 270, 995 | 5, 561 | 458, 210 | 360, 132 | 239, 417 | 1, 328, 754 | 105, 045 | 1, 433, 799 | 172 |
| Saline | 240 | 13, 200 | 234 | 2, 900 | 8, 900 | 7, 450 | 32, 450 | 5, 300 | 37, 750 | 16 |
| Sangamon | 4, 798 | 216, 500 | 1, 036 | 82, 000 | 379, 750 | 214, 350 | 892, 600 | 97, 850 | 990, 450 | 136 |
| Schuyler | | | 360 | 21, 750 | 7, 100 | 12, 200 | 41, 050 | 2, 700 | 43, 750 | 6 |
| Scott, Shelby, and Stark | 6 | 600 | 250 | 18, 500 | 2, 900 | 1, 420 | 23, 420 | 2, 770 | 26, 190 | 2 |
| Tazewell | 438 | 32, 400 | 340 | 44, 600 | 10, 500 | 13, 000 | 100, 500 | 6, 600 | 107, 100 | 13 |
| Vermilion | 4, 873 | 380, 881 | 311 | 31, 856 | 147, 429 | 55, 105 | 615, 271 | 52, 134 | 667, 405 | 95 |
| Washington | | | 157 | 7, 850 | 10, 000 | 9, 500 | 27, 350 | 2, 800 | 30, 150 | 7 |
| Will | 2, 670 | 124, 250 | 90 | 8, 600 | 65, 596 | 10, 590 | 209, 036 | 71, 100 | 280, 136 | 71 |
| Williamson | 160 | 4, 000 | 2, 813 | 101, 650 | 18, 200 | 27, 253 | 151, 103 | 12, 600 | 163, 703 | 21 |
| Woodford | 165 | 9, 000 | | | 89, 790 | 17, 000 | 115, 790 | 18, 000 | 133, 790 | 18 |

## INDIANA.

What is known as the Central or Illinois coal field extends eastward over the southwestern portion of Indiana, underlying an area of about 7,000 square miles, and includes 19 counties, Warren county lying at the northern limit, and a line drawn through the eastern boundary of Greene county marking its extent eastward. The coals of this state, like those of Illinois and western Kentucky, which comprise the remaining portion of the field, are bituminous and excellent for steam and heating purposes, but of little value for the manufacture of coke and gas. Cannel coal, which appears in pockets in various portions of the Indiana region, has not attained more than local importance, either for domestic fuel or for the manufacture of gas.

There being no authorized system of collecting the statistics of production of coal in this state, the figures published heretofore from year to year must be taken as approximates to some extent. The state mine inspector, in the course of his duties, has secured whatever data were available on the subject, and his estimates may be relied upon as representing very nearly the actual facts. Assuming these figures to be correct, it is found that the production of coal in the state has declined since 1887, the year of maximum output. This condition is owing to the introduction of natural gas into the cities and larger towns, together with the use of crude oil as fuel at Chicago and elsewhere, thereby displacing the Indiana coals in many important neighboring markets.

The production as reported by the mine inspector was as follows for the years named: 1887, 3,217,711 short tons; 1888, 3,140,979 short tons. The product for the year 1889 as reported to the census was 2,845,057 short tons, valued at $2,887,852, an average of $1.02 per ton, at the mines. During the year ended June 30, 1880, the quantity of coal produced in the state, as reported to the Tenth Census, was 1,454,327 short tons, valued at $2,150,258, an average of $1.48 per ton, at the mines.

The following table shows, by counties, the number of mines, the total product, and the disposition of the same, together with the total amount received for coal sold and the average price per ton at the mines:

COAL PRODUCT OF INDIANA FOR 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | MINES. | | Total product of coal of all grades for 1889. | DISPOSITION OF TOTAL PRODUCT. | | | | | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Regular. | Local. | | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | Manufactured into coke. | | |
| Total | 94 | 256 | 2, 845, 057 | 2, 527, 112 | 217, 041 | 20, 894 | 67, 210 | 12, 800 | $2, 887, 852 | $1. 02 |
| Clay | 28 | 29 | 695, 649 | 647, 442 | 27, 042 | 4, 608 | 16, 557 | .......... | 795, 140 | 1. 14 |
| Daviess | 8 | 13 | 191, 585 | 176, 244 | 9, 384 | 3, 035 | 2, 922 | .......... | 195, 793 | 1. 02 |
| Dubois | 2 | 13 | 15, 848 | 5, 917 | 9, 343 | 188 | 400 | .......... | 18, 500 | 1. 17 |
| Fountain | 2 | 7 | 41, 141 | 38, 485 | 1, 991 | 300 | 365 | .......... | 53, 218 | 1. 29 |
| Gibson | 1 | 6 | 1, 267 | 128 | 1, 059 | 40 | 40 | .......... | 1, 941 | 1. 53 |
| Greene | 3 | 12 | 185, 849 | 175, 753 | 2, 351 | 880 | 6, 865 | .......... | 169, 595 | 0. 91 |
| Knox | 2 | 4 | 9, 040 | 7. 200 | 1, 816 | 24 | .......... | .......... | 10, 405 | 1. 15 |
| Martin | .......... | 4 | 710 | .......... | 700 | 10 | .......... | .......... | 887 | 1. 25 |
| Owen | 1 | 15 | 3, 958 | 225 | 3, 683 | 20 | 30 | .......... | 4. 292 | 1. 08 |
| Parke | 4 | 11 | 357, 434 | 344, 658 | 5, 030 | 1, 370 | 6, 376 | .......... | 377, 324 | 1. 06 |
| Perry | 2 | 15 | 40, 050 | 27, 186 | 12, 166 | 118 | 580 | .......... | 47, 175 | 1. 18 |
| Pike | 3 | 32 | 154, 524 | 138, 380 | 7, 805 | 682 | 2, 857 | 4, 800 | 128, 867 | 0. 83 |
| Spencer | 2 | 26 | 18, 456 | 14, 934 | 3, 117 | 5 | 400 | .......... | 21, 207 | 1. 15 |
| Sullivan | 12 | 11 | 317, 252 | 271, 977 | 19, 728 | 2, 184 | 15, 363 | 8, 000 | 299, 286 | 0. 94 |
| Vanderburg | 6 | .......... | 183, 942 | 89, 820 | 84, 909 | 2, 685 | 6, 528 | .......... | 212, 572 | 1. 16 |
| Vermilion | 4 | 14 | 187, 651 | 178, 925 | 4, 152 | 2, 274 | 2, 300 | .......... | 167, 590 | 0. 89 |
| Vigo | 8 | 13 | 371, 903 | 353, 685 | 11, 415 | 1, 902 | 4, 900 | .......... | 330, 205 | 0. 89 |
| Warren | .......... | 9 | 2, 160 | .......... | 2, 160 | .......... | .......... | .......... | 3, 555 | 1. 65 |
| Warrick | 6 | 22 | 66, 638 | 56, 153 | 9, 190 | 568 | 727 | .......... | 50, 300 | 0. 75 |

The following table gives the number of employés of all kinds in Indiana mines, both above and below ground, the average wages paid per day, and the amount of wages paid during 1889:

LABOR AND WAGES AT INDIANA COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mines. | ABOVE GROUND. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Total | 6, 448 | 666 | 74 | $2. 36 | 255 | 160 | $1. 84 | 256 | 426 | $1. 47 | 192 | 6 | $0. 71 | 152 |
| Clay | 2, 592 | 245 | 29 | 2. 52 | 225 | 63 | 1. 85 | 255 | 149 | 1. 53 | 141 | 4 | 0. 78 | 131 |
| Daviess | 455 | 63 | 2 | 2. 89 | 294 | 20 | 1. 64 | 248 | 40 | 1. 38 | 172 | 1 | 0. 75 | 160 |
| Dubois | 41 | 6 | 2 | 2. 02 | 333 | 1 | 2. 37 | 300 | 3 | 1. 39 | 150 | .......... | .......... | .......... |
| Fountain | 85 | 11 | 2 | 2. 50 | 300 | 4 | 1. 75 | 232 | 5 | 1. 50 | 238 | .......... | .......... | .......... |
| Gibson | 7 | 2 | 1 | 1. 50 | 60 | .......... | .......... | .......... | 1 | 1. 25 | 40 | .......... | .......... | .......... |
| Greene | 296 | 29 | 1 | 2. 00 | 250 | 7 | 2. 00 | 312 | 21 | 1. 53 | 190 | .......... | .......... | .......... |
| Knox | 22 | 3 | 1 | 1. 25 | 120 | .......... | .......... | .......... | 2 | 1. 25 | 237 | .......... | .......... | .......... |
| Owen | 17 | 5 | 1 | 1. 50 | 41 | 1 | 1. 50 | 25 | 3 | 1. 00 | 50 | .......... | .......... | .......... |
| Parke | 591 | 50 | 4 | 2. 72 | 281 | 18 | 1. 84 | 288 | 28 | 1. 50 | 268 | .......... | .......... | .......... |
| Perry | 109 | 18 | 3 | 1. 59 | 327 | 3 | 1. 44 | 267 | 12 | 1. 11 | 242 | .......... | .......... | .......... |
| Pike | 340 | 30 | 3 | 2. 45 | 260 | 5 | 2. 01 | 276 | 22 | 1. 31 | 277 | .......... | .......... | .......... |
| Spencer | 29 | 5 | 2 | 1. 56 | 225 | .......... | .......... | .......... | 3 | 1. 17 | 250 | .......... | .......... | .......... |
| Sullivan | 556 | 62 | 11 | 2. 18 | 253 | 15 | 1. 93 | 244 | 35 | 1. 50 | 211 | 1 | 0. 50 | 225 |
| Vanderburg | 318 | 42 | 6 | 2. 35 | 335 | 8 | 1. 94 | 289 | 28 | 1. 36 | 236 | .......... | .......... | .......... |
| Vermilion | 276 | 34 | 4 | 2. 63 | 311 | 9 | 2. 03 | 231 | 21 | 1. 47 | 239 | .......... | .......... | .......... |
| Vigo | 629 | 48 | 1 | 2. 00 | 313 | 3 | 1. 84 | 117 | 44 | 1. 70 | 227 | .......... | .......... | .......... |
| Warrick | 85 | 13 | 1 | 2. 44 | 300 | 3 | 1. 42 | 247 | 9 | 1. 03 | 159 | .......... | .......... | .......... |

LABOR AND WAGES AT INDIANA COAL MINES IN 1889, BY COUNTIES—Continued.

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Total | 5,782 | 135 | $2.37 | 170 | 4,738 | $1.89 | 175 | 820 | $1.70 | 182 | 89 | $0.72 | 184 | $2,144,566 |
| Clay | 2,347 | 83 | 2.39 | 104 | 1,906 | 1.84 | 126 | 318 | 1.76 | 124 | 40 | 0.84 | 117 | 623,772 |
| Daviess | 392 | 6 | 2.39 | 250 | 291 | 2.06 | 169 | 79 | 1.50 | 221 | 16 | 0.42 | 269 | 164,557 |
| Dubois | 35 | 1 | 1.50 | 300 | 30 | 1.57 | 175 | 4 | 1.41 | 175 | | | | 12,371 |
| Fountain | 74 | 1 | 2.00 | 300 | 65 | 2.25 | 215 | 8 | 1.66 | 233 | | | | 39,984 |
| Gibson | 5 | | | | 4 | 1.50 | 40 | 1 | 1.50 | 40 | | | | 440 |
| Greene | 267 | 2 | 2.50 | 312 | 223 | 2.20 | 190 | 40 | 1.80 | 177 | 2 | 0.85 | 155 | 114,664 |
| Knox | 19 | 1 | 2.50 | 237 | 16 | 1.66 | 164 | 2 | 1.50 | 237 | | | | 6,150 |
| Owen | 12 | | | | 10 | 1.00 | 50 | 2 | 1.25 | 33 | | | | 800 |
| Parke | 541 | 4 | 3.00 | 300 | 474 | 2.00 | 260 | 63 | 1.99 | 271 | | | | 308,249 |
| Perry | 91 | 2 | 1.56 | 283 | 70 | 1.20 | 229 | 17 | 1.62 | 244 | 2 | 0.40 | 250 | 31,313 |
| Pike | 310 | 2 | 2.43 | 275 | 251 | 2.04 | 165 | 54 | 1.44 | 172 | 3 | 0.50 | 230 | 106,097 |
| Spencer | 24 | 2 | 1.75 | 250 | 20 | 1.52 | 188 | 2 | 1.13 | 250 | | | | 8,900 |
| Sullivan | 494 | 10 | 2.24 | 272 | 435 | 1.64 | 213 | 37 | 1.66 | 210 | 12 | 0.73 | 208 | 197,646 |
| Vanderburg | 276 | 6 | 2.68 | 291 | 176 | 2.00 | 250 | 82 | 1.48 | 249 | 12 | 1.02 | 250 | 146,647 |
| Vermilion | 242 | 4 | 2.31 | 276 | 201 | 2.03 | 228 | 35 | 1.91 | 232 | 2 | 1.00 | 182 | 128,405 |
| Vigo | 581 | 8 | 2.49 | 300 | 510 | 1.84 | 193 | 63 | 1.93 | 197 | | | | 231,682 |
| Warrick | 72 | 3 | 1.84 | 212 | 56 | 1.52 | 184 | 13 | 1.19 | 174 | | | | 22,889 |

The following table shows the office force employed and the amount expended during the year 1889:

EXPENDITURES AT INDIANA COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| Total | 84 | $56,478 | 77 | $54,038 | 7 | $2,440 | 6,532 | $2,201,044 | $241,094 | $133,724 | $2,575,862 | $5,807 | $2,581,669 |
| Clay | 19 | 13,555 | 18 | 13,465 | 1 | 90 | 2,611 | 637,327 | 74,286 | 42,908 | 754,521 | | 754,521 |
| Daviess | 11 | 6,481 | 11 | 6,481 | | | 466 | 171,038 | 9,781 | 19,966 | 200,785 | | 200,785 |
| Dubois | 2 | 1,100 | 1 | 900 | 1 | 200 | 43 | 13,471 | 300 | 700 | 14,471 | | 14,471 |
| Fountain and Gibson | | | | | | | 92 | 40,424 | 5,700 | 5,320 | 51,444 | 2,000 | 53,444 |
| Greene | 8 | 4,800 | 8 | 4,800 | | | 304 | 119,464 | 9,250 | 17,935 | 146,649 | 800 | 147,449 |
| Knox | | | | | | | 22 | 6,150 | 650 | 750 | 7,550 | | 7,550 |
| Owen and Parke | 4 | 2,800 | 4 | 2,800 | | | 612 | 311,849 | 37,515 | 1,625 | 350,989 | | 350,989 |
| Perry | 3 | 3,680 | 3 | 3,680 | | | 112 | 34,993 | 3,325 | 1,835 | 40,153 | | 40,153 |
| Pike | 2 | 800 | 1 | 500 | 1 | 300 | 342 | 106,897 | 7,806 | 2,197 | 116,900 | | 116,900 |
| Spencer | 1 | 900 | 1 | 900 | | | 30 | 9,800 | 1,000 | 700 | 11,500 | | 11,500 |
| Sullivan | 10 | 6,930 | 10 | 6,930 | | | 566 | 204,576 | 28,052 | 7,378 | 240,006 | | 240,006 |
| Vanderburg | 16 | 10,280 | 12 | 8,430 | 4 | 1,850 | 334 | 156,927 | 20,481 | 12,589 | 189,997 | 1,500 | 191,497 |
| Vermilion | 4 | 3,520 | 4 | 3,520 | | | 280 | 131,925 | 14,500 | 14,186 | 160,611 | | 160,611 |
| Vigo | 4 | 1,632 | 4 | 1,632 | | | 633 | 233,314 | 25,150 | 2,448 | 260,912 | 1,507 | 262,419 |
| Warrick | | | | | | | 85 | 22,889 | 3,298 | 3,187 | 29,374 | | 29,374 |

The following table gives the value of mines and improvements and the power used in mining:

VALUE OF AND POWER AT INDIANA COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | | | POWER USED IN MINING. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | Steam boilers. | | Number of cylinders. | Number of animals. |
| | Acres. | Value. | Acres. | Value. | | | | | | Number. | Horse power. | | |
| Total | 15, 785 | $1,213,445 | 9, 023 | $576, 050 | $553, 449 | $719, 463 | $3, 062, 407 | $373, 296 | $3, 435, 703 | 198 | 6, 652 | 167 | 719 |
| Clay | 3, 881 | 517, 460 | 3, 035 | 344, 190 | 142, 225 | 190, 370 | 1, 194, 245 | 162, 018 | 1, 356, 263 | 74 | 2, 460 | 53 | 219 |
| Daviess | 1, 130 | 63, 000 | 485 | 25, 050 | 28, 300 | 56, 235 | 172, 585 | 26, 000 | 198, 585 | 10 | 290 | 17 | 91 |
| Dubois | ........ | ........ | 660 | 30, 000 | 6, 500 | 6, 000 | 42, 500 | 1, 400 | 43, 900 | 1 | 30 | 4 | 3 |
| Fountain and Gibson | 84 | 4, 225 | 800 | 36, 000 | 11, 000 | 4, 275 | 55, 500 | 7, 500 | 63, 000 | 3 | 101 | 3 | 6 |
| Greene | ........ | ........ | 1, 165 | 63, 250 | 36, 694 | 38, 511 | 138, 455 | 19, 600 | 158, 055 | 10 | 340 | 8 | 36 |
| Knox | 40 | 800 | 160 | 3, 200 | 700 | 700 | 5, 400 | 1, 150 | 6, 550 | ........ | ........ | ........ | 2 |
| Owen and Parke | 1, 528 | 90, 800 | 24 | 600 | 35, 400 | 88, 600 | 215, 400 | 33, 925 | 249, 325 | 26 | 740 | 15 | 71 |
| Perry | 3, 000 | 50, 000 | 10 | 1, 000 | 3, 500 | 36, 000 | 90, 500 | 5, 350 | 95, 850 | 2 | 60 | 2 | 27 |
| Pike | 1, 600 | 54, 000 | 160 | 3, 500 | 20, 000 | 11, 000 | 88, 500 | 17, 700 | 106, 200 | 6 | 180 | 5 | 49 |
| Spencer | ........ | ........ | 400 | 6, 500 | 6, 500 | 3, 000 | 16, 000 | 1, 600 | 17, 600 | 1 | 30 | 1 | 9 |
| Sullivan | 1, 827 | 157, 110 | 502 | 8, 510 | 63, 185 | 181, 000 | 409, 805 | 24, 860 | 434, 665 | 18 | 965 | 28 | 67 |
| Vanderburg | 631 | 155, 000 | 322 | 7, 500 | 85, 500 | 49, 000 | 297, 000 | 19, 400 | 316, 400 | 16 | 605 | 9 | 46 |
| Vermilion | 500 | 25, 000 | 480 | 9, 600 | 17, 000 | 20, 972 | 72, 572 | 16, 600 | 89, 172 | 8 | 220 | 8 | 35 |
| Vigo | 897 | 77, 000 | 480 | 29, 600 | 91, 045 | 28, 400 | 226, 045 | 32, 643 | 258, 688 | 18 | 500 | 9 | 46 |
| Warrick | 667 | 19, 050 | 340 | 7, 550 | 5, 900 | 5, 400 | 37, 900 | 3, 550 | 41, 450 | 5 | 131 | 5 | 12 |

## INDIAN TERRITORY.

The Western or Fourth field, which comprises the only deposits of the carboniferous measures west of the Mississippi river, extends across the boundaries of Kansas, Missouri, and Arkansas into the Indian territory, underlying almost the entire eastern half of that territory. The present developments of importance are along the line of the Missouri, Kansas and Texas railway, in the Choctaw Nation reservation, and are conducted by the Osage Coal and Mining Company at McAlester and the Atoka Mining Company at Lehigh.

The Choctaw Coal and Mining Company is constructing a line of railroad from the Arkansas state line, passing through Oklahoma, to the western boundary of the territory, and southward to Denison, Texas, intersected by the Saint Louis and Kansas Pacific, the Missouri, Kansas and Texas, the Atchison, Topeka and Santa Fe, and the Chicago, Rock Island and Pacific railroads. This company is engaged in developing a large area of excellent coal territory, lying along the route of the projected railroad, secured by lease from the Choctaw nation. This enterprise will constitute one of the most important in the southwest.

The quality of the coal now being mined in this territory is excellent for steam and heating purposes, and is well suited for gas and coking. The beds from which the product is obtained range from 3 to 5 feet in thickness, and comprise the 2 lower veins, which are here found to be of much greater thickness and freer from bone and other impurities than in any other part of the field. Competent authorities assert that the coals now being mined in the Indian territory are superior to any found west of the Appalachian field.

The total product in the territory during the calendar year 1889 was 752,832 short tons, valued at $1,323,807. The average number of persons employed during the year was 1,873; the total wages paid, $927,267. No report of mining operations in this territory was made for the Tenth Census.

COAL PRODUCT OF INDIAN TERRITORY IN 1889.

[Short tons.]

| LOCALITIES. | MINES. | | Total product of coal of all grades for year 1889. | DISPOSITION OF TOTAL PRODUCT. | | | | | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Regular. | Local. | | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | Manufactured into coke. | | |
| Total | 15 | ........ | 752, 832 | 699, 122 | 1, 173 | 5, 922 | 33, 997 | 12, 618 | $1, 323, 807 | $1. 76 |
| Atoka | 4 | ........ | 323, 080 | 312, 236 | 630 | 3, 097 | 7, 117 | ........ | 600, 838 | 1. 86 |
| Choctaw nation | 5 | ........ | 428, 748 | 386, 350 | 75 | 2, 825 | 26, 880 | 12, 618 | 720, 961 | 1. 68 |
| Tobucksy | 6 | ........ | 1, 004 | 536 | 468 | ........ | ........ | ........ | 2, 008 | 2. 00 |

### LABOR AND WAGES AT INDIAN TERRITORY COAL MINES IN 1889, BY COUNTIES.

| LOCALITIES. | Total employés about mine. | ABOVE GROUND. | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total average number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked | Average number employed. | Average wages per day. | Average number of days worked. |
| Atoka and Choctaw nation. | 1,862 | 220 | 11 | $2.55 | 291 | 63 | $2.50 | 170 | 145 | $1.90 | 164 | 1 | $1.00 | 250 |

| LOCALITIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total average number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Atoka and Choctaw nation. | 1,642 | 10 | $3.10 | 252 | 1,200 | $3.25 | 166 | 393 | $2.41 | 177 | 39 | $0.88 | 198 | $915,567 |

### EXPENDITURES AT INDIAN TERRITORY COAL MINES IN 1889, BY COUNTIES.

| LOCALITIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Male. | | Female. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| Total | 11 | $11,700 | 11 | $11,700 | .......... | .......... | 1,873 | $927,267 | $53,404 | $172,150 | $1,152,821 | $20,000 | $1,172,821 |
| Atoka | 5 | 5,220 | 5 | 5,220 | .......... | .......... | 959 | 435,892 | 28,860 | 48,562 | 513,314 | .......... | 513,314 |
| Choctaw nation | 6 | 6,480 | 6 | 6,480 | .......... | .......... | 914 | 491,375 | 24,544 | 123,588 | 639,507 | .......... | 639,507 |
| Tobucksy | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | 20,000 | 20,000 |

### VALUE OF AND POWER AT INDIAN TERRITORY COAL MINES IN 1889, BY COUNTIES.

| LOCALITIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | POWER USED IN MINING. | | | | | | | DAYS IDLE DURING YEAR. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | Steam boilers. | | Cylinders. | | Other power. | | | | |
| | | | | | | | | | | | | Motors. | | Number of animals employed. | Repairs to mines and machinery. | Short of cars. |
| | Acres. | Value. | | | | | | Number. | Horse power. | Number. | Size. (Inches.) | Number. | Horse power. | | | |
| Total | 14,766 | $738,643 | $497,509 | $131,067 | $1,367,219 | $124,790 | $1,492,009 | 38 | 1,680 | 38 | .......... | 2 | 30 | 169 | 8 | 22.25 |
| Atoka | 6,326 | 316,298 | 251,498 | 98,203 | 665,999 | 69,790 | 735,789 | 15 | 680 | 17 | .......... | .......... | .......... | 89 | 8 | 22.25 |
| Choctaw nation | 5,440 | 272,345 | 236,011 | 22,864 | 531,220 | 55,000 | 586,220 | 19 | 760 | 16 | .......... | 2 | 30 | 80 | .......... | .......... |
| Tobucksy | 3,000 | 150,000 | 10,000 | 10,000 | 170,000 | .......... | 170,000 | 4 | 240 | 1<br>4 | 18 x 36<br>16 x 30 | .......... | .......... | .......... | .......... | .......... |

## IOWA.

Almost one-half of the state of Iowa is underlaid with coal. The northern extremity of the great Fourth field occupies the southern portion of the state, extending across the southeastern counties of Nebraska, thence southward through Kansas, Missouri, Arkansas, Texas, and Indian territory. Coal is produced in 26 counties, and is of a quality generally well adapted for steam and heating purposes. No cannel or gas coal is found in the state.

The quantity of coal produced in Iowa during the census year ended June 30, 1880, from 25 counties was 1,461,116 short tons, valued at $2,507,453 at the mines. The wages paid aggregated $1,554,696, and the average number of persons employed was 5,024. The total product of all grades during the calendar year 1889 was 4,095,358 short tons, valued at $5,426,509. The average number of persons employed during the year was 9,384, and the amount of wages paid $3,956,788.

The principal lines of transportation for the product are as follows:

- Chicago, Burlington and Quincy railroad.
- Chicago, Milwaukee and Saint Paul railroad.
- Iowa Central railroad.
- Wabash railroad.
- Fort Madison and Northwestern railroad.
- Chicago, Rock Island and Pacific railroad.
- Chicago, Burlington and Kansas City railroad.
- Humestown and Shenandoah railroad.
- Ottumwa and Kirkville railroad.
- Keokuk and Western railroad.
- Chicago and Northwestern railroad.
- Burlington, Cedar Rapids and Northern railroad.
- Chicago, Saint Paul and Kansas City railroad.
- Des Moines and Kansas City railroad.
- Mason City and Fort Dodge railroad.
- Minneapolis and Saint Louis railroad.
- Webster City and Southwestern railroad.

### COAL PRODUCT OF IOWA IN 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | MINES. | | Total product of coal of all grades for year 1889. | DISPOSITION OF TOTAL PRODUCT. | | | | | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Regular. | Local. | | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | Manufactured into coke. | | |
| Total | 166 | 226 | 4,095,358 | 3,530,373 | 420,596 | 44,139 | 100,213 | 37 | $5,426,509 | $1.33 |
| Adams | 1 | 13 | 13,457 | 800 | 12,010 | 627 | 20 | .......... | 27,870 | 2.07 |
| Appanoose | 30 | 20 | 285,194 | 252,881 | 22,845 | 2,992 | 6,476 | .......... | 376,473 | 1.32 |
| Boone | 16 | 6 | 174,392 | 125,858 | 38,614 | 5,865 | 4,030 | 25 | 324,302 | 1.86 |
| Cass | .......... | 1 | 280 | .......... | 280 | .......... | .......... | .......... | 700 | 2.50 |
| Dallas | 2 | 5 | 67,055 | 60,309 | 4,557 | 1,019 | 1,170 | .......... | 111,472 | 1.66 |
| Davis | .......... | 4 | 3,825 | .......... | 3,800 | 20 | 5 | .......... | 5,409 | 1.41 |
| Greene | 5 | 1 | 51,438 | 41,429 | 6,077 | 695 | 3,237 | .......... | 89,704 | 1.74 |
| Guthrie | 1 | 24 | 12,275 | .......... | 11,904 | 371 | .......... | .......... | 30,852 | 2.51 |
| Hardin | .......... | 2 | 490 | .......... | 490 | .......... | .......... | .......... | 1,370 | 2.80 |
| Jasper | 5 | 14 | 199,152 | 171,120 | 16,228 | 1,625 | 10,179 | .......... | 282,081 | 1.42 |
| Jefferson | 2 | 6 | 8,123 | 3,341 | 4,192 | 536 | 54 | .......... | 12,609 | 1.55 |
| Keokuk | 15 | 5 | 455,162 | 417,751 | 13,758 | 5,007 | 18,646 | .......... | 569,190 | 1.25 |
| Lucas | 2 | 8 | 339,229 | 318,523 | 10,195 | 121 | 10,390 | .......... | 416,307 | 1.23 |
| Mahaska | 15 | 20 | 1,056,477 | 992,393 | 35,533 | 6,763 | 21,788 | .......... | 1,222,954 | 1.16 |
| Marion | 11 | 12 | 145,180 | 124,325 | 17,527 | 1,996 | 1,332 | .......... | 185,266 | 1.28 |
| Monroe | 12 | 6 | 258,401 | 244,306 | 6,546 | 2,043 | 5,506 | .......... | 300,786 | 1.16 |
| Montgomery | .......... | 1 | 1,040 | .......... | 1,003 | 37 | .......... | .......... | 2,280 | 2.19 |
| Page | .......... | 5 | 2,768 | .......... | 2,590 | 176 | 2 | .......... | 6,770 | 2.45 |
| Polk | 17 | 2 | 434,047 | 284,310 | 129,137 | 9,739 | 10,861 | .......... | 687,969 | 1.59 |
| Scott | .......... | 5 | 9,446 | .......... | 9,446 | .......... | .......... | .......... | 15,181 | 1.61 |
| Taylor | 2 | 7 | 9,736 | 3,800 | 5,686 | 250 | .......... | .......... | 20,122 | 2.07 |
| Van Buren | 4 | 3 | 39,258 | 34,891 | 3,848 | 58 | 461 | .......... | 54,617 | 1.39 |
| Wapello | 9 | 17 | 359,199 | 331,702 | 21,869 | 964 | 4,652 | 12 | 406,445 | 1.13 |
| Warren | 2 | 16 | 14,515 | 4,984 | 8,882 | 449 | 200 | .......... | 25,819 | 1.78 |
| Wayne | 2 | 8 | 17,480 | 7,489 | 9,137 | 674 | 180 | .......... | 25,751 | 1.47 |
| Webster | 13 | 15 | 137,739 | 110,161 | 24,442 | 2,112 | 1,024 | .......... | 224,210 | 1.63 |

### LABOR AND WAGES AT IOWA COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mine. | ABOVE GROUND. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total average number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Total | 9,247 | 1,075 | 147 | $2.20 | 228 | 202 | $2.21 | 253 | 709 | $1.57 | 209 | 17 | $0.78 | 169 |
| Appanoose | 1,044 | 103 | 26 | 2.04 | 212 | 17 | 1.80 | 240 | 56 | 1.52 | 180 | 4 | 0.81 | 133 |
| Boone | 653 | 99 | 12 | 2.01 | 253 | 15 | 2.00 | 241 | 70 | 1.68 | 159 | 2 | 0.75 | 145 |
| Greene | 175 | 23 | 5 | 1.91 | 131 | 2 | 2.25 | 165 | 16 | 1.50 | 194 | .......... | .......... | .......... |
| Jasper | 464 | 35 | 6 | 1.80 | 255 | 8 | 2.03 | 187 | 21 | 1.57 | 204 | .......... | .......... | .......... |
| Keokuk | 890 | 144 | 12 | 2.14 | 265 | 31 | 2.31 | 290 | 101 | 1.54 | 224 | .......... | .......... | .......... |
| Lucas | 704 | 48 | .......... | .......... | .......... | 20 | 2.12 | 238 | 28 | 1.39 | 211 | .......... | .......... | .......... |
| Mahaska | 1,648 | 176 | 12 | 2.34 | 257 | 33 | 2.66 | 289 | 130 | 1.58 | 257 | 1 | 1.00 | 216 |
| Marion | 349 | 40 | 10 | 2.05 | 182 | 9 | 1.96 | 259 | 20 | 1.63 | 179 | 1 | 0.50 | 245 |
| Monroe | 690 | 89 | 12 | 2.60 | 251 | 15 | 2.27 | 246 | 60 | 1.55 | 181 | 2 | 0.83 | 102 |
| Polk | 1,020 | 123 | 14 | 2.36 | 243 | 22 | 2.20 | 239 | 85 | 1.62 | 223 | 2 | 0.75 | 130 |
| Van Buren | 89 | 14 | 3 | 1.92 | 212 | 3 | 1.75 | 302 | 8 | 1.47 | 272 | .......... | .......... | .......... |
| Wapello | 726 | 96 | 10 | 2.75 | 266 | 17 | 2.04 | 226 | 65 | 1.52 | 204 | 4 | 0.79 | 210 |
| Webster | 414 | 39 | 11 | 2.30 | 194 | 2 | 2.31 | 200 | 25 | 1.71 | 190 | 1 | 0.75 | 290 |
| Other counties (*a*) | 381 | 46 | 14 | 1.86 | 200 | 8 | 1.94 | 233 | 24 | 1.51 | 173 | .......... | .......... | .......... |

*a* Adams, Dallas, Guthrie, Jefferson, Taylor, Warren, and Wayne.

## LABOR AND WAGES AT IOWA COAL MINES IN 1889, BY COUNTIES—Continued.

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total average number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number days worked. | Average number employed. | Average wages per day. | Average number days worked. | Average number employed. | Average wages per day. | Average number days worked. | Average number employed. | Average wages per day. | Average number days worked. | |
| Total | 8,172 | 139 | $2.46 | 251 | 6,588 | $2.23 | 196 | 1,191 | $1.89 | 217 | 254 | $0.77 | 200 | $3,860,893 |
| Appanoose | 941 | 23 | 2.14 | 230 | 751 | 1.74 | 171 | 137 | 1.74 | 205 | 30 | 0.55 | 197 | 318,769 |
| Boone | 554 | 13 | 2.30 | 284 | 460 | 1.94 | 166 | 68 | 1.73 | 189 | 13 | 0.86 | 132 | 209,178 |
| Greene | 152 | 4 | 2.49 | 191 | 123 | 1.93 | 170 | 23 | 1.72 | 181 | 2 | 1.00 | 175 | 58,848 |
| Jasper | 429 | 7 | 2.57 | 235 | 353 | 2.20 | 190 | 47 | 2.13 | 226 | 22 | 0 98 | 205 | 179,525 |
| Keokuk | 746 | 9 | 2.76 | 265 | 654 | 2.31 | 223 | 65 | 1.94 | 231 | 18 | 0.75 | 207 | 427,616 |
| Lucas | 656 | 6 | 2.83 | 270 | 491 | 3.14 | 154 | 135 | 1.68 | 216 | 24 | 0.60 | 154 | 311,036 |
| Mahaska | 1,472 | 15 | 2.71 | 295 | 1,185 | 2.50 | 231 | 218 | 2.10 | 251 | 54 | 0.90 | 237 | 902,945 |
| Marion | 309 | 9 | 2.22 | 261 | 257 | 2.17 | 169 | 39 | 1.70 | 194 | 4 | 1.00 | 154 | 124,526 |
| Monroe | 601 | 8 | 2.70 | 278 | 468 | 2.26 | 174 | 101 | 1.77 | 188 | 24 | 0.75 | 181 | 231,557 |
| Polk | 897 | 14 | 2.69 | 252 | 737 | 2.02 | 222 | 124 | 1.92 | 201 | 22 | 0.68 | 210 | 439,013 |
| Van Buren | 75 | 4 | 2.06 | 233 | 63 | 1.96 | 254 | 8 | 1.75 | 251 | ........ | ........ | ........ | 40,924 |
| Wapello | 630 | 8 | 2.53 | 253 | 475 | 2.44 | 206 | 115 | 2.00 | 239 | 32 | 0.66 | 230 | 343,050 |
| Webster | 375 | 11 | 2.30 | 229 | 305 | 1.89 | 182 | 50 | 1.85 | 218 | 9 | 1.00 | 138 | 141,899 |
| Other counties (*a*) | 335 | 8 | 2.14 | 179 | 266 | 1.82 | 172 | 61 | 1.73 | 188 | ........ | ........ | ........ | 132,007 |

## EXPENDITURES AT AND VALUE OF IOWA COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| Total | 137 | $95,895 | 130 | $93,131 | 7 | $2,764 | 9,384 | $3,956,788 | $357,033 | $353,935 | $4,667,756 | $65,194 | $4,732,950 |
| Adams and Appanoose. | 20 | 10,840 | 19 | 10,440 | 1 | 400 | 1,070 | 331,409 | 19,311 | 27,415 | 378,135 | 6,866 | 385,001 |
| Boone and Dallas | 20 | 13,812 | 20 | 13,812 | ........ | ........ | 861 | 311,187 | 31,452 | 27,284 | 369,923 | 1,900 | 371,823 |
| Greene and Guthrie | 6 | 4,149 | 6 | 4,149 | ........ | ........ | 196 | 67,220 | 3,350 | 10,298 | 80,868 | ........ | 80,868 |
| Jasper and Jefferson. | 6 | 3,620 | 6 | 3,620 | ........ | ........ | 488 | 187,372 | 20,130 | 4,950 | 212,452 | ........ | 212,452 |
| Keokuk and Lucas | 7 | 5,520 | 6 | 4,920 | 1 | 600 | 1,601 | 744,172 | 65,940 | 63,552 | 873,664 | 3,660 | 877,324 |
| Mahaska | 16 | 20,640 | 14 | 19,620 | 2 | 1,020 | 1,664 | 923,585 | 67,769 | 51,291 | 1,042,645 | 150 | 1,042,795 |
| Marion | 6 | 3,664 | 5 | 3,400 | 1 | 264 | 355 | 128,190 | 12,295 | 11,407 | 151,892 | 1,064 | 152,956 |
| Monroe | 13 | 8,063 | 13 | 8,063 | ........ | ........ | 703 | 239,620 | 18,081 | 22,666 | 280,367 | 30,410 | 310,777 |
| Polk and Taylor | 17 | 10,698 | 16 | 10,398 | 1 | 300 | 1,062 | 457,211 | 86,272 | 91,846 | 635,329 | 20,993 | 656,322 |
| Van Buren | 1 | 600 | 1 | 600 | ........ | ........ | 90 | 41,524 | 2,923 | 4,125 | 48,572 | ........ | 48,572 |
| Wayne and Warren. | 1 | 148 | 1 | 148 | ........ | ........ | 130 | 26,208 | 2,000 | 10,925 | 39,133 | ........ | 39,133 |
| Wapello | 14 | 7,071 | 13 | 6,891 | 1 | 180 | 740 | 350,121 | 12,287 | 18,898 | 381,306 | 151 | 381,457 |
| Webster | 10 | 7,070 | 10 | 7,070 | ........ | ........ | 424 | 148,969 | 15,223 | 9,278 | 173,470 | ........ | 173,470 |

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | | | Number of animals employed. |
|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | |
| | Acres. | Value. | Acres. | Value. | | | | | | |
| Total | 24,239 | $2,178,832 | 14,443 | $945,749 | $1,210,421 | $1,330,927 | $5,665,929 | $613,250 | $6,279,179 | 929 |
| Adams and Appanoose | 686 | 29,720 | 3,110 | 153,555 | 116,960 | 106,169 | 406,404 | 40,032 | 446,436 | 95 |
| Boone and Dallas | 2,350 | 122,900 | 1,922 | 113,714 | 84,465 | 77,154 | 398,233 | 46,680 | 444,913 | 60 |
| Greene and Guthrie | 370 | 31,300 | 160 | 3,200 | 23,300 | 18,700 | 76,500 | 12,700 | 89,200 | 25 |
| Jasper and Jefferson | 1,289 | 123,200 | 170 | 8,500 | 17,600 | 34,200 | 183,500 | 24,715 | 208,215 | 41 |
| Keokuk and Lucas | 3,483 | 370,813 | 2,770 | 291,261 | 386,769 | 171,268 | 1,220,111 | 102,605 | 1,322,716 | 189 |
| Mahaska | 9,138 | 801,400 | 180 | 32,950 | 209,720 | 555,675 | 1,599,745 | 152,897 | 1,752,642 | 157 |
| Marion | 1,946 | 175,898 | 970 | 44,500 | 17,499 | 44,946 | 282,843 | 24,350 | 307,193 | 56 |
| Monroe | 1,876 | 274,350 | 1,631 | 77,395 | 110,650 | 98,700 | 561,095 | 48,600 | 609,695 | 82 |
| Polk and Taylor | 1,165 | 75,220 | 1,366 | 115,780 | 142,279 | 132,693 | 465,972 | 72,440 | 538,412 | 92 |
| Van Buren | 240 | 13,500 | 320 | 13,019 | 10,590 | 8,256 | 45,365 | 4,400 | 49,765 | 14 |
| Wayne and Warren | ........ | ........ | 498 | 18,100 | 8,900 | 9,600 | 36,600 | 22,100 | 58,700 | 14 |
| Wapello | 886 | 81,600 | 720 | 38,600 | 57,900 | 53,941 | 232,041 | 35,000 | 267,041 | 68 |
| Webster | 810 | 78,931 | 626 | 35,175 | 23,789 | 19,625 | 157,520 | 26,731 | 184,251 | 36 |

*a* Adams, Dallas, Guthrie, Jefferson, Taylor, Warren, and Wayne.

## KANSAS.

The coal measures of Kansas cover an area of about 17,000 square miles, underlying the entire eastern portion of the state. The coals are bituminous in character, similar to the coals of other states in the great Western or Fourth field, and are found to be excellent for coking, steam, gas, smelting, and domestic purposes. Lignite deposits have also been worked to some extent for local trade along the western limits of the coal areas in Cloud, Ellsworth, Jewell, Republic, and Russell counties. Although coal deposits are known to exist in about 20 counties in the state, regular mining operations are conducted in but 8, namely, Cherokee, Coffey, Crawford, Franklin, Labette, Leavenworth, Linn, and Osage, while in the remaining counties operations are confined to country banks, supplying local trade.

The varying grades of these coals and their excellent quality have attracted attention to this large but hitherto somewhat neglected field, and the output is therefore rapidly increasing.

The principal transportation lines reaching the mines in 1889, as reported to the Eleventh Census, were as follows:

Chicago, Rock Island and Pacific railway.
Atchison, Topeka and Santa Fe railroad.
Missouri Pacific railway.
Kansas City, Wyandotte and Northwestern railway.
Saint Louis and San Francisco railway.
Kansas City, Fort Scott and Memphis railroad.

The veins vary from 1 to 5 feet in thickness, and are mined by shaft as well as by "stripping". The scarcity of wood for fuel in the western part of the state is stimulating the development of coal beds as well as the construction of branch railroad lines to meet the increasing demands of the growing population.

The output for the calendar year 1889 is reported to the Census Office as 2,221,043 short tons, valued at $3,296,888, or an average of $1.48 per ton, at the mines. The average number of persons employed in 1889 was 6,069, and the amount of wages paid $2,320,588. The total product reported at the Tenth Census was 771,442 short tons, valued at $1,517,444; total number of employés, 3,617; total amount of wages paid, $758,980.

The state conducts coal-mining operations upon an extensive scale at Lansing, in Leavenworth county. The convicts in the penitentiary are employed at these mines, and the product, after supplying the statehouse and public institutions, is sold in the open market.

### COAL PRODUCT OF KANSAS AND NEBRASKA IN 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | MINES. |  | Total product of coal of all grades for year 1889. | DISPOSITION OF TOTAL PRODUCT. |  |  |  |  | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|---|---|
|  | Regular. | Local. |  | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | Manufactured into coke. |  |  |
| Total | 127 | 297 | 2, 222, 443 | 1, 891, 090 | 267, 047 | 34, 560 | 29, 246 | 500 | $3, 301, 788 | $1. 49 |
| KANSAS. |  |  |  |  |  |  |  |  |  |  |
| Bourbon |  | 80 | 19, 150 |  | 17, 824 | 1, 326 |  |  | 32, 092 | 1. 68 |
| Chautauqua |  | 5 | 4, 274 |  | 4, 206 | 68 |  |  | 12, 451 | 2. 91 |
| Cherokee | 21 | 11 | 549, 073 | 516, 616 | 17, 141 | 7, 737 | 7, 079 | 500 | 662, 858 | 1. 21 |
| Cloud |  | 13 | 8. 475 |  | 8, 421 | 33 | 21 |  | 21, 496 | 2. 54 |
| Coffey | 3 | 25 | 18. 272 | 1, 602 | 16, 470 | 200 |  |  | 35, 488 | 1. 94 |
| Crawford | 23 | 2 | 827, 159 | 812, 700 | 2, 929 | 5, 617 | 5, 913 |  | 971, 857 | 1. 17 |
| Ellsworth |  | 7 | 5, 390 |  | 5, 390 |  |  |  | 17, 026 | 3. 16 |
| Franklin | 3 | 39 | 37, 771 | 10, 666 | 27, 105 |  |  |  | 82, 499 | 2. 18 |
| Jewell |  | 1 | 800 |  | 800 |  |  |  | 2, 400 | 3. 00 |
| Labette | 1 | 5 | 2, 541 | 80 | 2, 333 | 128 |  |  | 5, 773 | 2. 27 |
| Leavenworth | 4 |  | 245. 616 | 174, 557 | 51. 837 | 5, 402 | 13, 820 |  | 415, 751 | 1. 69 |
| Lincoln |  | 8 | 6, 427 |  | 6, 427 |  |  |  | 20, 723 | 3. 22 |
| Linn | 8 | 16 | 25, 345 | 12, 401 | 12, 280 | 584 | 80 |  | 33, 665 | 1. 33 |
| Lyon |  | 5 | 4, 365 |  | 4, 365 |  |  |  | 12, 160 | 2. 79 |
| Mitchell |  | 2 | 960 |  | 960 |  |  |  | 3, 840 | 4. 00 |
| Nemaha |  | 2 | 2, 171 |  | 2, 171 |  |  |  | 7, 870 | 3. 63 |
| Osage | 64 | 58 | 446, 018 | 362, 468 | 67, 832 | 13, 385 | 2, 333 |  | 903, 602 | 2. 03 |
| Republic |  | 1 | 986 |  | 926 | 60 |  |  | 2, 710 | 2. 75 |
| Russell |  | 8 | 6, 703 |  | 6, 703 |  |  |  | 22, 065 | 3. 29 |
| Shawnee |  | 8 | 9, 547 |  | 9, 527 | 20 |  |  | 30, 562 | 3. 20 |
| Total | 127 | 296 | 2, 221, 043 | 1, 891, 090 | 265, 647 | 34, 560 | 29, 246 | 500 | 3, 296, 888 | 1. 48 |
| NEBRASKA. |  |  |  |  |  |  |  |  |  |  |
| Richardson |  | 1 | 1, 400 |  | 1, 400 |  |  |  | 4, 900 | 3. 50 |

## LABOR AND WAGES AT KANSAS COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mine. | ABOVE GROUND. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total average number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Total | 5,956 | 742 | 69 | $2.37 | 190 | 160 | $2.23 | 200 | 488 | $1.55 | 197 | 25 | $0.79 | 156 |
| Cherokee | 1,196 | 160 | 7 | 2.11 | 258 | 31 | 2.08 | 206 | 115 | 1.64 | 147 | 7 | 0.81 | 139 |
| Coffey | 25 | 10 | 3 | 2.33 | 114 | 5 | 2.25 | 121 | 2 | 1.10 | 118 | ........ | ........ | ........ |
| Crawford | 1,629 | 183 | 10 | 2.05 | 182 | 35 | 2.23 | 289 | 130 | 1.60 | 177 | 8 | 0.75 | 165 |
| Franklin and Labette. | 75 | 25 | 5 | 2.00 | 117 | 13 | 2.25 | 118 | 6 | 1.86 | 162 | 1 | 0.50 | 116 |
| Leavenworth | 937 | 116 | 8 | 3.63 | 300 | 22 | 2.34 | 290 | 85 | 1.15 | 247 | 1 | 1.00 | 194 |
| Linn | 62 | 23 | 3 | 1.67 | 220 | 5 | 2.00 | 62 | 14 | 1.78 | 249 | 1 | 0.75 | 300 |
| Osage | 2,032 | 225 | 33 | 2.14 | 166 | 49 | 2.25 | 136 | 136 | 1.71 | 225 | 7 | 0.83 | 144 |

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total average number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Total | 5,214 | 103 | $2.46 | 230 | 4,447 | $1.89 | 207 | 456 | $1.75 | 222 | 208 | $0.88 | 219 | $2,258,485 |
| Cherokee | 1,036 | 14 | 2.91 | 234 | 855 | 2.55 | 170 | 139 | 1.95 | 175 | 28 | 1.08 | 176 | 502,150 |
| Coffey | 15 | ........ | ........ | ........ | 15 | 2.00 | 100 | ........ | ........ | ........ | ........ | ........ | ........ | 5,397 |
| Crawford | 1,446 | 13 | 2.62 | 277 | 1,178 | 2.09 | 226 | 209 | 1.85 | 232 | 46 | 0.84 | 239 | 721,050 |
| Franklin and Labette. | 50 | 4 | 2.24 | 193 | 41 | 1.45 | 221 | 4 | 0.75 | 240 | 1 | 0.50 | 190 | 22,132 |
| Leavenworth | 821 | 9 | 3.03 | 265 | 713 | 1.67 | 221 | 66 | 1.32 | 275 | 33 | 1.02 | 274 | 326,882 |
| Linn | 39 | 3 | 1.67 | 237 | 31 | 1.31 | 200 | 4 | 1.19 | 202 | 1 | 0.75 | 300 | 18,685 |
| Osage | 1,807 | 60 | 2.26 | 215 | 1,614 | 1.58 | 206 | 34 | 1.72 | 249 | 99 | 0.79 | 204 | 662,189 |

## EXPENDITURES AT KANSAS COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number | Amount of wages. | | | | | | | |
| Total | 113 | $62,103 | 99 | $60,469 | 14 | $1,634 | 6,069 | $2,320,588 | $262,820 | $141,044 | $2,724,452 | $6,330 | $2,730,782 |
| Cherokee | 18 | 12,085 | 16 | 11,410 | 2 | 675 | 1,214 | 514,235 | 26,389 | 15,304 | 555,928 | 3,000 | 558,928 |
| Coffey | 2 | 175 | 1 | 125 | 1 | 50 | 27 | 5,572 | 317 | 373 | 6,262 | ........ | 6,262 |
| Crawford | 15 | 14,006 | 15 | 14,006 | ........ | ........ | 1,644 | 735,056 | 96,264 | 51,879 | 883,199 | 25 | 883,224 |
| Franklin and Labette. | 8 | 1,476 | 7 | 1,426 | 1 | 50 | 83 | 23,608 | 1,789 | 1,883 | 27,280 | ........ | 27,280 |
| Leavenworth | 14 | 14,420 | 14 | 14,420 | ........ | ........ | 951 | 341,302 | 101,819 | 42,460 | 485,581 | 2,000 | 487,581 |
| Linn | 1 | 250 | 1 | 250 | ........ | ........ | 63 | 18,935 | 1,471 | 1,480 | 21,886 | 5 | 21,891 |
| Osage | 55 | 19,691 | 45 | 18,832 | 10 | 859 | 2,087 | 681,880 | 34,771 | 27,665 | 744,316 | 1,300 | 745,616 |

VALUE OF AND POWER AT KANSAS COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | | | POWER USED IN MINING. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | Steam boilers. | | Number of animals employed. |
| | Acres. | Value. | Acres. | Value. | | | | | | Number. | Horse power. | |
| Total | 36,077 | $1,588,974 | 3,939 | $285,760 | 629,438 | 652,416 | $3,156,588 | 331,951 | $3,488,539 | 71 | 3,279 | 605 |
| Bourbon | | | | | | | | | | | | |
| Chautauqua | | | | | | | | | | | | |
| Cherokee and Coffey. | 4,414 | 335,430 | 524 | 20,700 | 79,468 | 87,449 | 523,047 | 82,281 | 605,328 | 22 | 870 | 126 |
| Cloud | | | | | | | | | | | | |
| Crawford | 16,863 | 960,403 | 1,134 | 108,300 | 287,177 | 226,751 | 1,582,631 | 93,825 | 1,676,456 | 16 | 669 | 158 |
| Ellsworth | | | | | | | | | | | | |
| Franklin and Labette. | 367 | 13,630 | 123 | 5,150 | 3,211 | 4,461 | 26,452 | 4,900 | 31,352 | | | 41 |
| Jewell | | | | | | | | | | | | |
| Leavenworth and Linn. | 1,959 | 124,000 | 286 | 11,700 | 192,500 | 266,822 | 595,022 | 59,565 | 654,587 | 33 | 1,740 | 72 |
| Lincoln | | | | | | | | | | | | |
| Lyon | | | | | | | | | | | | |
| Mitchell | | | | | | | | | | | | |
| Nemaha | | | | | | | | | | | | |
| Osage | 12,474 | 155,511 | 1,872 | 139,910 | 67,082 | 66,933 | 429,436 | 91,380 | 520,816 | | | 208 |
| Republic | | | | | | | | | | | | |
| Russell | | | | | | | | | | | | |
| Shawnee | | | | | | | | | | | | |

## KENTUCKY.

The coal areas of this state represent both the Appalachian and the Central or Illinois fields. The Appalachian field covers the entire eastern section of the state to the extent of 10,000 square miles, and underlies wholly or in part 31 counties. Operations on a commercial scale are conducted in the following counties in the southeastern district, namely, Bell, Knox, Laurel, Pulaski, Rockcastle, and Whitley, and in the northeastern district in Boyd, Carter, Lawrence, Johnson, and Martin counties. In addition, small local mines are reported in Breathitt, Clay, Edmonson, Floyd, Harlan, Jackson, Knott, Leslie, Letcher, Madison, Magoffin, Menifee, Morgan, Owsley, Perry, Pike, Powell, Rockcastle, Wayne, and Wolfe counties.

In the western part of the state the lower extremity of the Central or Illinois field extends over an area of about 4,000 square miles, underlying the counties of Butler, Christian, Crittenden, Daviess, Edmonson, Greenup, Hancock, Henderson, Hopkins, McLean, Muhlenberg, Ohio, Todd, Union, and Webster. 12 different coal seams are identified in this district, but only 5 are worked to any extent. While in the eastern, as in the western, portion of the state as many as 10 or 12 distinct seams have been noted, but one or two attain such uniformity of thickness and persistency of area as to warrant extensive mining operations.

The coal is generally semibituminous, free burning, and noncoking, but the various seams comprise all varieties, from bituminous shale to the finest grades of cannel coal. Some fair coking coals are mined in Hopkins county, in the western district, and in Bell county, in the southeastern district. This state possesses some of the finest beds of cannel coal known in the country, which are found in both the eastern and western districts, and the product is distributed widely for domestic grate fuel into the eastern cities, competing successfully with the English cannels. Indeed, much of it is shipped abroad into markets hitherto controlled by Australian and English coal.

The product of coal in Kentucky during the census year ended June 30, 1880, was 946,288 short tons, valued at $1,134,960, an average of $1.20 per ton, at the mines. During the year 1889 the total product was 2,399,755 short tons, valued at $2,374,339, an average of 99 cents per ton, at the mines.

The following table shows the production of coal in Kentucky in 1889 and the disposition of the same:

### COAL PRODUCT OF KENTUCKY IN 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | MINES. | | Total product of coal of all grades for 1889. | DISPOSITION OF TOTAL PRODUCT. | | | | | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Regular. | Local. | | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | Manufactured into coke. | | |
| Total | 79 | 1,762 | 2,399,755 | 2,111,010 | 225,234 | 21,072 | 23,981 | 18,458 | $2,374,339 | $0.99 |
| Bell | 3 | 32 | 20,095 | 3,270 | 13,084 | 114 | 57 | 3,570 | 28,144 | 1.40 |
| Boyd | 2 | 12 | 163,124 | 161,030 | 1,294 | 800 | | | 179,385 | 1.10 |
| Breathitt | | 42 | 353 | | 353 | | | | 324 | 0.92 |
| Butler | | 37 | 6,489 | | 6,489 | | | | 8,054 | 1.24 |
| Carter | 8 | 16 | 172,776 | 167,301 | 2,833 | 944 | 1,698 | | 196,892 | 1.14 |
| Christian | 1 | 4 | 27,281 | 23,154 | 1,112 | 15 | 3,000 | | 34,348 | 1.26 |
| Clay | | 90 | 5,170 | | 5,170 | | | | 6,207 | 1.20 |
| Crittenden | 1 | [illegible] | 5,286 | 3,976 | 1,270 | 40 | | | 5,604 | 1.06 |
| Daviess | 1 | 70 | 30,870 | | 30,600 | 194 | 76 | | 40,231 | 1.30 |
| Edmonson | | 13 | 78 | | 78 | | | | 78 | 1.00 |
| Elliott | | 59 | 1,100 | | 1,100 | | | | 1,247 | 1.13 |
| Floyd | | 102 | 2,236 | | 2,236 | | | | 2,433 | 1.09 |
| Grayson | | 6 | 492 | | 492 | | | | 615 | 1.25 |
| Greenup | | 11 | 632 | | 632 | | | | 792 | 1.25 |
| Hancock | 2 | 16 | 21,588 | 16,110 | 5,418 | 60 | | | 34,087 | 1.58 |
| Harlan | | 79 | 785 | | 785 | | | | 820 | 1.04 |
| Henderson | 4 | 7 | 65,682 | 39,473 | 22,829 | 1,822 | 1,558 | | 82,457 | 1.26 |
| Hopkins | 9 | 30 | 555,119 | 508,927 | 16,005 | 7,323 | 7,976 | 14,888 | 434,606 | 0.78 |
| Jackson | | 35 | 568 | | 568 | | | | 568 | 1.00 |
| Johnson | 3 | 174 | 32,347 | 24,544 | 7,550 | 5 | 248 | | 54,178 | 1.67 |
| Knott | | 66 | 1,158 | | 1,158 | | | | 1,052 | 0.91 |
| Knox and Lee | 1 | 1 | 48,703 | 47,503 | 1,200 | | | | 42,200 | 0.87 |
| Laurel | 14 | 28 | 280,451 | 273,244 | 6,165 | 739 | 303 | | 251,122 | 0.90 |
| Lawrence | 1 | 37 | 79,787 | 77,683 | 1,504 | 600 | | | 107,103 | 1.34 |
| Leslie | | 21 | 1,271 | | 1,271 | | | | 1,271 | 1.00 |
| Letcher | | 66 | 1,573 | | 1,573 | | | | 1,257 | 0.80 |
| McLean | 2 | 23 | 35,177 | 23,345 | 11,764 | 48 | 20 | | 41,199 | 1.17 |
| Madison | | 2 | 175 | | 175 | | | | 265 | 1.51 |
| Magoffin | | 66 | 5,404 | | 5,404 | | | | 6,623 | 1.23 |
| Martin | | 19 | 660 | | 660 | | | | 800 | 1.21 |
| Menifee | | 3 | 1,160 | | 1,160 | | | | 1,450 | 1.25 |
| Morgan | | 94 | 1,061 | | 1,061 | | | | 1,061 | 1.00 |
| Muhlenberg | 7 | 48 | 206,855 | 194,339 | 8,721 | 2,593 | 1,202 | | 180,654 | 0.87 |
| Ohio | 6 | 61 | 246,253 | 221,385 | 19,284 | 3,383 | 2,201 | | 200,497 | 0.81 |
| Owsley | | 77 | 2,201 | | 2,201 | | | | 2,751 | 1.25 |
| Perry | | 39 | 349 | | 349 | | | | 349 | 1.00 |
| Pike | | 66 | 1,962 | | 1,962 | | | | 1,962 | 1.00 |
| Powell | | 8 | 69 | | 69 | | | | 69 | 1.00 |
| Pulaski | 3 | 7 | 84,363 | 78,420 | 2,085 | 658 | 3,200 | | 109,587 | 1.30 |
| Rockcastle | | 16 | 1,432 | | 1,432 | | | | 1,790 | 1.25 |
| Todd | | 8 | 530 | | 530 | | | | 663 | 1.25 |
| Union | 5 | 13 | 56,556 | 41,278 | 13,651 | 273 | 1,354 | | 63,803 | 1.13 |
| Wayne | | 12 | 1,457 | | 1,457 | | | | 1,821 | 1.25 |
| Webster | 2 | 15 | 32,729 | 26,776 | 5,855 | 92 | 6 | | 26,379 | 0.81 |
| Whitley | 4 | 68 | 184,874 | 179,252 | 3,171 | 1,369 | 1,082 | | 203,264 | 1.10 |
| Wolfe | | 32 | 11,474 | | 11,474 | | | | 14,277 | 1.24 |

The following table shows the office force employed and the amount expended in coal-mining operations during the year 1889:

### EXPENDITURES AT KENTUCKY COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| Total | 116 | $86, 839 | 111 | $84, 639 | 5 | $2, 200 | 5, 260 | $1, 756, 363 | $237, 321 | $117, 765 | $2, 111, 449 | $45, 099 | $2, 156, 548 |
| Bell | 2 | 920 | 2 | 920 | | | 110 | 20, 139 | 22, 476 | 8, 632 | 51, 247 | | 51, 247 |
| Boyd | 1 | 900 | 1 | 900 | | | 247 | 98, 320 | 8, 000 | 5, 000 | 111, 320 | 800 | 112, 120 |
| Carter | 16 | 11, 075 | 15 | 10, 975 | 1 | 100 | 448 | 150, 425 | 12, 640 | 11, 813 | 174, 878 | | 174, 878 |
| Christian | 2 | 1, 720 | 2 | 1, 720 | | | 105 | 26, 723 | 13, 716 | 2, 047 | 42, 486 | | 42, 486 |
| Crittenden | 2 | 900 | 2 | 900 | | | 11 | 2, 706 | 1, 000 | 200 | 3, 906 | | 3, 906 |
| Daviess | 1 | 540 | 1 | 540 | | | 14 | 5, 040 | 3, 500 | | 8, 540 | | 8, 540 |
| Hancock | 1 | 600 | 1 | 600 | | | 71 | 22, 362 | 1, 950 | 750 | 25, 062 | | 25, 062 |
| Henderson | 2 | 1, 320 | 2 | 1, 320 | | | 150 | 59, 255 | 6, 074 | 4, 101 | 69, 430 | | 69, 430 |
| Hopkins | 19 | 11, 785 | 17 | 11, 185 | 2 | 600 | 923 | 353, 095 | 21, 882 | 18, 206 | 393, 183 | | 393, 183 |
| Johnson | 3 | 2, 100 | 3 | 2, 100 | | | 92 | 31, 734 | 4, 389 | 697 | 36, 820 | 100 | 36, 920 |
| Knox and Lee | 1 | 750 | 1 | 750 | | | 124 | 36, 950 | 4, 000 | 1, 000 | 41, 950 | | 41, 950 |
| Laurel | 18 | 14, 620 | 18 | 14, 620 | | | 817 | 243, 846 | 31, 503 | 11, 375 | 286, 724 | 16, 174 | 302, 898 |
| Lawrence | 3 | 2, 730 | 3 | 2, 730 | | | 177 | 65, 944 | 5, 674 | 1, 400 | 73, 018 | | 73, 018 |
| McLean | | | | | | | 45 | 12, 643 | 2, 200 | 2, 000 | 16, 843 | 200 | 17, 043 |
| Muhlenberg | 13 | 9, 936 | 13 | 9, 936 | | | 407 | 123, 258 | 14, 129 | 6, 223 | 143, 610 | 2, 025 | 145, 635 |
| Ohio | 8 | 4, 750 | 7 | 4, 450 | 1 | 300 | 406 | 164, 713 | 8, 800 | 3, 440 | 176, 953 | | 176, 953 |
| Pulaski | 8 | 5, 670 | 8 | 5, 670 | | | 286 | 93, 569 | 47, 312 | 26, 688 | 167, 569 | 13, 380 | 180, 949 |
| Union | 2 | 1, 012 | 2 | 1, 012 | | | 171 | 50, 637 | 1, 111 | 5, 088 | 56, 836 | | 56, 836 |
| Webster | 3 | 4, 500 | 3 | 4, 500 | | | 81 | 34, 388 | 15, 050 | 1, 000 | 50, 438 | 7, 500 | 57, 938 |
| Whitley | 11 | 11, 011 | 10 | 9, 811 | 1 | 1, 200 | 575 | 160, 616 | 11, 915 | 8, 105 | 180, 636 | 4, 920 | 185, 556 |

The following table shows the value of Kentucky coal mines and improvements and the power employed in the mines:

### VALUE OF AND POWER AT KENTUCKY COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | | | POWER USED IN MINING. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | Steam boilers. | | Cylinders. | | Number of animals. |
| | Acres. | Value. | Acres. | Value. | | | | | | No. | Horse power. | No. | Size. (Inches.) | |
| Total | 106, 622 | $2, 827, 755 | 21, 478 | $1, 050, 240 | $1, 364, 523 | $1, 007, 951 | $6, 250, 469 | $330, 911 | $6, 581, 380 | 70 | 2, 559 | | | 723 |
| Bell | | | 2, 800 | 164, 000 | 25, 000 | 26, 750 | 215, 750 | 16, 000 | 231, 750 | | | | | 28 |
| Boyd | 12, 000 | 120, 000 | | | 5, 000 | 20, 000 | 145, 000 | 15, 000 | 160, 000 | 1 | 100 | 2 | 18 x 24 | 43 |
| Carter | 15, 980 | 159, 600 | 25 | 625 | 69, 400 | 66, 600 | 296, 225 | 24, 900 | 321, 125 | 2 | 40 | | | 71 |
| Christian | | | 593 | 76, 000 | 14, 800 | 17, 500 | 108, 300 | 8, 000 | 116, 300 | 3 | 250 | | | 11 |
| Crittenden | 200 | 1, 500 | | | 3, 500 | 1, 000 | 6, 000 | 1, 500 | 7, 500 | | | | | 4 |
| Daviess | 53 | 5, 300 | | | 3, 500 | 1, 200 | 10, 000 | 900 | 10, 900 | | | | | 2 |
| Hancock | 3, 700 | 170, 000 | | | 15, 300 | 10, 100 | 195, 400 | 3, 600 | 199, 000 | 1 | 40 | | | 7 |
| Henderson | | | 463 | 18, 700 | 20, 500 | 24, 106 | 63, 306 | 5, 985 | 69, 291 | 5 | 220 | | | 17 |
| Hopkins | 4, 361 | 133, 525 | 14, 270 | 702, 800 | 165, 897 | 208, 302 | 1, 210, 524 | 57, 916 | 1, 268, 440 | 12 | 590 | | | 139 |
| Johnson | 5, 050 | 186, 400 | | | 17, 500 | 10, 600 | 214, 500 | 4, 120 | 218, 620 | | | | | 4 |
| Knox and Lee | 2, 500 | 40, 000 | | | 60, 000 | 25, 000 | 125, 000 | 6, 000 | 131, 000 | | | | | 10 |
| Laurel | 6, 368 | 166, 709 | 322 | 8, 150 | 67, 203 | 180, 083 | 422, 145 | 30, 668 | 452, 813 | 7 | 209 | | | 71 |
| Lawrence | 6, 000 | 300, 000 | | | 150, 000 | 150, 000 | 600, 000 | 7, 600 | 607, 600 | 2 | 150 | | | 20 |
| McLean | 40 | 8, 000 | | | 6, 000 | 3, 000 | 17, 000 | 6, 000 | 23, 000 | 1 | 20 | | | 20 |
| Muhlenberg | 6, 360 | 378, 680 | 1, 000 | 11, 500 | 188, 500 | 82, 550 | 661, 230 | 49, 900 | 711, 130 | 10 | 290 | | | 45 |
| Ohio | 3, 000 | 217, 120 | 360 | 10, 880 | 79, 500 | 33, 095 | 340, 595 | 39, 847 | 380, 442 | 4 | 76 | | | 71 |
| Pulaski | 29, 550 | 147, 000 | | | 272, 970 | 36, 974 | 456, 944 | 22, 500 | 479, 444 | 8 | 220 | | | 48 |
| Union | 2, 072 | 25, 000 | 835 | 37, 335 | 20, 985 | 15, 250 | 98, 570 | 8, 200 | 106, 770 | 8 | 245 | | | 34 |
| Webster | 30 | 1, 500 | 810 | 20, 250 | 7, 350 | 6, 100 | 35, 200 | 1, 775 | 36, 975 | 2 | 60 | | | 8 |
| Whitley | 9, 358 | 767, 421 | | | 171, 618 | 89, 741 | 1, 028, 780 | 20, 500 | 1, 049, 280 | 4 | 49 | | | 70 |

The following table shows the labor employed at the mines, both above and below ground, the average wages paid per day, and the total amount of wages paid in 1889:

LABOR AND WAGES AT KENTUCKY COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mines. | ABOVE GROUND. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Total | 5,144 | 893 | 76 | $2.44 | 270 | 152 | $1.81 | 242 | 627 | $1.30 | 204 | 38 | $0.75 | 205 |
| Carter | 432 | 80 | 8 | 2.02 | 302 | 9 | 1.70 | 268 | 57 | 1.31 | 227 | 6 | 0.59 | 237 |
| Henderson | 148 | 37 | 2 | 2.03 | 333 | 7 | 1.66 | 203 | 25 | 1.27 | 247 | 3 | 0.75 | 240 |
| Hopkins | 904 | 197 | 9 | 2.57 | 315 | 30 | 1.91 | 241 | 150 | 1.22 | 243 | 8 | 0.75 | 201 |
| Laurel | 799 | 121 | 14 | 2.30 | 267 | 12 | 1.98 | 235 | 95 | 1.31 | 230 | ........ | ........ | ........ |
| Muhlenberg | 394 | 67 | 6 | 2.67 | 293 | 14 | 1.89 | 218 | 47 | 1.21 | 162 | ........ | ........ | ........ |
| Ohio | 398 | 48 | 6 | 2.33 | 263 | 8 | 2.06 | 266 | 32 | 1.53 | 205 | 2 | 0.90 | 200 |
| Pulaski | 278 | 88 | 7 | 2.23 | 253 | 36 | 1.54 | 263 | 45 | 1.31 | 110 | ........ | ........ | ........ |
| Union | 169 | 43 | 6 | 2.33 | 245 | 5 | 2.40 | 214 | 30 | 1.25 | 165 | 2 | 1.00 | 208 |
| Whitley | 564 | 84 | 6 | 2.85 | 221 | 10 | 2.07 | 163 | 61 | 1.42 | 185 | 7 | 0.75 | 146 |
| Other counties (*a*) | 1,058 | 128 | 12 | 2.85 | 247 | 21 | 1.81 | 236 | 85 | 1.33 | 181 | 10 | 0.78 | 219 |

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Total | 4,251 | 59 | $2.33 | 255 | 3,406 | $1.75 | 193 | 674 | $1.56 | 219 | 112 | $0.70 | 213 | $1,669,524 |
| Carter | 352 | 6 | 1.69 | 295 | 297 | 1.54 | 220 | 35 | 1.30 | 245 | 14 | 0.54 | 273 | 139,350 |
| Henderson | 111 | 3 | 1.71 | 264 | 84 | 1.86 | 227 | 20 | 1.34 | 244 | 4 | 0.50 | 240 | 57,935 |
| Hopkins | 707 | 8 | 2.80 | 288 | 404 | 1.98 | 181 | 266 | 1.61 | 252 | 29 | 0.73 | 225 | 341,310 |
| Laurel | 678 | 7 | 2.17 | 246 | 595 | 1.80 | 215 | 60 | 1.49 | 228 | 16 | 0.84 | 233 | 229,226 |
| Muhlenberg | 327 | 7 | 2.57 | 275 | 262 | 1.96 | 152 | 49 | 1.53 | 142 | 9 | 0.78 | 137 | 113,322 |
| Ohio | 350 | 6 | 3.08 | 263 | 290 | 1.97 | 201 | 54 | 1.60 | 204 | ........ | ........ | ........ | 159,963 |
| Pulaski | 190 | 2 | 2.25 | 250 | 170 | 1.73 | 189 | 16 | 1.61 | 193 | 2 | 1.12 | 276 | 87,899 |
| Union | 126 | 2 | 2.00 | 208 | 98 | 1.60 | 180 | 24 | 1.46 | 151 | 2 | 1.00 | 208 | 49,625 |
| Whitley | 480 | 3 | 2.50 | 204 | 415 | 1.90 | 139 | 46 | 1.84 | 160 | 16 | 0.68 | 153 | 149,605 |
| Other counties (*a*) | 930 | 15 | 2.10 | 228 | 791 | 1.51 | 212 | 104 | 1.48 | 206 | 20 | 0.62 | 211 | 341,289 |

*a* The counties here grouped, in order that the business of individual establishments may not be disclosed to the public, are Bell, Boyd, Christian, Crittenden, Daviess, Hancock, Johnson, Knox, Lawrence, McLean, and Webster.

## MARYLAND.

The coal fields of Maryland are a part of the extensive basin lying between the Daniss and Great Savage mountains, extending from the Pennsylvania state line through the western section of the state to Cheat river, near the southern boundary of Tucker county, in West Virginia, and constitute what are known as the Elk Garden and Cumberland regions. The George's Creek or Cumberland region of Maryland is located in Allegany and Garrett counties, and extends from the North Branch of the Potomac river at Piedmont to the Pennsylvania state line, a distance of about 30 miles, although actual mining operations cover only about one-half that distance. The comparatively large production of coal from this limited area is furnished transportation facilities to the tide-water and interior markets by the Cumberland and Pennsylvania and the George's Creek and Cumberland railroads, which traverse the region, reaching the Pennsylvania railroad at Cumberland and the Baltimore and Ohio at Piedmont. The Chesapeake and Ohio canal, until its partial destruction by flood in 1889, formed an avenue for the movement of a large portion of this product to tide water at Georgetown, District of Columbia.

Mining operations have been conducted in this locality for about half a century. Up to the close of the year 1889 the total shipments amounted to over 66,000,000 tons. The coal produced is bituminous, and being essentially a steam fuel, the principal markets have been found at the great manufacturing cities of New England, as well as at the seaboard for the coaling of steamships.

During the census year there were in operation 31 establishments equipped for the shipping of coal. In addition, reports were received from 50 small operators supplying local trade. The total production for the census year 1889 was 2,939,715 short tons, valued at $2,517,474 at the mines, or an average of $0.86 per ton. The product for the census year ended June 30, 1880, was 2,228,917 short tons, valued at $2,585,537 at the mines, or

$1.16 per ton. The total number of persons employed in all departments, including superintendents, engineers, mechanics, and clerical force, during the census year was 3,741, and the amount of wages paid was $1,730,687. The average number of days worked when collieries were shipping coal was 196. During the calendar year 1888 the output amounted to 3,479,470 short tons. This falling off in the output during 1889 as compared with that of 1888 was due not so much to a decline in the demand as to want of transportation facilities, the result of the practical abandonment of the Chesapeake and Ohio canal.

### SHIPMENTS OF COAL FROM THE GEORGE'S CREEK OR CUMBERLAND REGION OF MARYLAND FROM 1870 TO 1889, INCLUSIVE.

[Long tons.]

| YEARS. | Total. | By Baltimore and Ohio railroad. | By Chesapeake and Ohio canal. | By Pennsylvania railroad. |
|---|---|---|---|---|
| Total | 42, 035, 733 | 27, 285, 325 | 10, 532, 579 | 4, 217, 829 |
| 1870 | 1, 628, 052 | 1, 023, 915 | 604, 137 | .................. |
| 1871 | 2, 167, 482 | 1, 317, 143 | 850, 339 | .................. |
| 1872 | 2, 148, 766 | 1, 310, 542 | 816, 203 | 22, 021 |
| 1873 | 2, 492, 726 | 1, 599, 335 | 778, 802 | 114, 589 |
| 1874 | 2, 254, 199 | 1, 419, 474 | 767, 064 | 67, 661 |
| 1875 | 2, 188, 436 | 1, 148, 385 | 879, 838 | 160, 213 |
| 1876 | 1, 718, 853 | 954, 547 | 632, 440 | 131, 866 |
| 1877 | 1, 574, 339 | 818, 459 | 584, 996 | 170, 884 |
| 1878 | 1, 688, 324 | 923, 256 | 619, 204 | 145, 864 |
| 1879 | 1, 730, 658 | 1, 075, 147 | 501, 247 | 154, 264 |
| 1880 | 2, 069, 587 | 1, 253, 016 | 603, 125 | 213, 446 |
| 1881 | 1, 960, 016 | 1, 384, 833 | 421, 682 | 153, 501 |
| 1882 | 1, 272, 122 | 780, 831 | 274, 620 | 216, 671 |
| 1883 | 1, 891, 495 | 1, 080, 656 | 499, 913 | 310, 926 |
| 1884 | 2, 453, 810 | 1, 561, 493 | 490, 956 | 401, 361 |
| 1885 | 2, 386, 887 | 1, 664, 647 | 359, 054 | 363, 186 |
| 1886 | 2, 152, 713 | 1, 630, 020 | 282, 802 | 239, 891 |
| 1887 | 2, 811, 883 | 2, 220, 067 | 262, 345 | 329, 471 |
| 1888 | 2, 934, 907 | 2, 204, 555 | 250, 519 | 479, 833 |
| 1889 | 2, 510, 478 | 1, 915, 004 | 53, 293 | 542, 181 |

### COAL PRODUCT OF MARYLAND IN 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | MINES. |  | Total product of coal of all grades for year 1889. | DISPOSITION OF TOTAL PRODUCT. |  |  |  | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|---|
|  | Regular. | Local. |  | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. |  |  |
| Total | 31 | 50 | 2, 939, 715 | 2, 885, 336 | 37, 667 | 6, 550 | 10, 162 | $2, 517, 474 | $0. 86 |
| Allegany | 30 | 11 | 2, 935, 081 | 2, 885, 114 | 33, 295 | 6, 510 | 10, 162 | 2, 512, 614 | 0. 86 |
| Garrett | 1 | 39 | 4, 634 | 222 | 4, 372 | 40 | ............ | 4, 860 | 1. 05 |

### LABOR AND WAGES AT MARYLAND COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mine | ABOVE GROUND. |  |  |  |  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  | Total average number employed. | Foremen or overseers. |  |  | Mechanics. |  |  | Laborers. |  |  | Boys under 16 years. |  |  |
|  |  |  | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Allegany and Garrett. | 3, 702 | 321 | 15 | $3. 04 | 266 | 65 | $2. 03 | 264 | 225 | $1. 59 | 196 | 16 | $0. 90 | 187 |

| COUNTIES. | BELOW GROUND. |  |  |  |  |  |  |  |  |  |  |  |  | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | Total average number employed. | Foremen or overseers. |  |  | Miners. |  |  | Laborers. |  |  | Boys under 16 years. |  |  |  |
|  |  | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |  |
| Allegany and Garrett. | 3, 381 | 22 | $3. 04 | 289 | 2, 689 | $2. 45 | 203 | 386 | $1. 86 | 222 | 284 | $1. 06 | 200 | $1, 700, 305 |

EXPENDITURES AT MARYLAND COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| Allegany and Garrett. | 39 | $30,382 | 39 | $30,382 | .......... | .......... | 3,741 | $1,730,687 | $203,155 | $121,453 | $2,055,295 | $5,763 | $2,061,058 |

VALUE OF AND POWER AT MARYLAND COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | | | POWER USED IN MINING. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | Steam boilers. | | Number of cylinders. | Other power. | | |
| | | | | | | | | | | | | | Motors. | | Number of animals employed. |
| | Acres. | Value. | Acres. | Value. | | | | | | Number. | Horse power. | | Number. | Horse power. | |
| Allegany and Garrett. | 48,100 | $15,707,629 | 2,420 | $176,000 | $1,521,655 | $392,193 | $17,797,477 | $227,890 | $18,025,367 | 31 | 916 | *a*21 | 4 | 132 | 310 |

*a* Sizes of cylinders: 8 x 10 and 20 x 48 inches.

## MISSOURI.

Coal is found in 39 counties in Missouri, the deposit being a part of what is known as the Fourth field, underlying portions of Iowa, Nebraska, Kansas, Missouri, Arkansas, and the Indian territory.

The geological surveys of the state have not yet clearly defined the outcroppings of the beds in the several counties, but mining operations have been conducted to a greater or less extent in the territory lying north of the Missouri river from the western boundary to the Mississippi river, and in the counties lying south of the Missouri river, between Kansas City and Jefferson City, and along the western boundary to Jasper and Dade counties. The principal developments are within Adair, Audrain, Barton, Bates, Caldwell, Callaway, Grundy, Henry, Johnson, Lafayette, Macon, Montgomery, Putnam, Randolph, Ray, and Vernon counties.

The coal is semibituminous, and is adapted for steam and heating purposes as well as for smithing. Deposits of cannel coal are found in Moniteau and Cooper counties.

The total product of all grades during the calendar year 1889 was 2,557,823 short tons, valued at $3,479,057 at the mines. The number of persons employed was 6,730, and $2,538,273 was paid in wages. During the census year 1880 the total product from 35 counties was 844,304 short tons, valued at $1,464,425, furnishing employment to 2,599 persons, to whom $642,772 was paid in wages.

Shipments are made directly from the mines upon the following transportation lines:

Kansas City, Fort Scott and Memphis railroad.
Missouri, Kansas and Texas railroad.
Quincy, Omaha and Kansas City railroad.
Chicago and Alton railroad.
Wabash railroad.
Hannibal and Saint Joseph railroad.
Missouri Pacific railroad.
Chicago, Rock Island and Pacific railroad.
Kansas City and Southern railroad.
Chicago, Burlington and Kansas City railroad.
Saint Joseph, Saint Louis and Santa Fe railroad.
Atchison, Topeka and Santa Fe railroad.

In the absence of any established division of the coal-bearing territory of the state into districts the statement following is submitted for convenience of identification.

## MISSOURI COAL DISTRICTS.

| DIVISIONS AND COUNTIES. | Districts. |
|---|---|
| Northeastern: | |
| Grundy | Trenton. |
| Livingston | Grand river. |
| Carroll | Do. |
| Sullivan | Green Castle. |
| Linn | Yellow creek. |
| Chariton | Chariton river. |
| Putnam | Do. |
| Schuyler | Do. |
| Adair | Do. |
| Macon | Bevier. |
| Randolph | Huntsville. |
| Howard | Bonne Femme creek. |
| Boone | Columbia. |
| Callaway | Fulton. |
| Audrain | Vandalia. |
| Ralls | Lick creek. |
| Montgomery | Lout Re river. |
| Monroe | Salt river. |
| Shelby | Do. |
| Eastern: | |
| Saint Louis | Saint Louis. |
| Northwestern: | |
| Nodaway | Nodaway river. |
| Ray | Richmond. |
| Caldwell | Hamilton. |
| Southwestern: | |
| Lafayette | Lexington. |
| Saline | Marshall. |
| Johnson | Black Water creek. |
| Bates | Rich hill. |
| Vernon | Do. |
| Henry | Tedbo creek. |
| Saint Clair | Vista. |
| Barton | Minden. |
| Jasper | Spring river. |
| Cooper | Booneville. |
| Moniteau | Moreau creek. |
| Dade | Cedar creek. |
| Cedar | Do. |
| Morgan | Versailles. |

## COAL PRODUCT OF MISSOURI IN 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | MINES. | | Total product of coal of all grades for year 1889. | DISPOSITION OF TOTAL PRODUCT. | | | | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|---|
| | Regular. | Local. | | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | | |
| Total | 122 | 356 | 2, 557, 823 | 2, 246, 845 | 259, 587 | 16, 412 | 34, 979 | $3, 479, 057 | $1. 36 |
| Adair | 2 | 6 | 18, 592 | 14, 729 | 3, 553 | 190 | 120 | 30, 860 | 1. 66 |
| Audrain | 2 | 16 | 26, 194 | 19, 238 | 5, 774 | 556 | 626 | 38, 490 | 1. 47 |
| Barton | 4 | 21 | 61, 167 | 53, 438 | 6, 360 | 569 | 800 | 82, 655 | 1. 35 |
| Bates | 21 | 26 | 755, 989 | 707, 215 | 44, 674 | 1, 500 | 2, 600 | 857, 060 | 1. 13 |
| Boone | 3 | 24 | 31, 405 | 19, 932 | 11, 285 | 168 | 20 | 48, 244 | 1. 54 |
| Caldwell | 1 | | 13, 594 | 11, 171 | 2, 153 | | 270 | 26, 810 | 1. 97 |
| Callaway | 1 | 9 | 16, 053 | 2, 004 | 13, 242 | 728 | 79 | 28, 727 | 1. 79 |
| Carroll | | 6 | 2, 439 | | 2, 439 | | | 4, 866 | 2. 00 |
| Cedar | | 11 | 2, 070 | | 2, 070 | | | 4, 137 | 2. 00 |
| Chariton | | 16 | 1, 961 | | 1, 951 | 10 | | 3, 692 | 1. 88 |
| Cooper | 1 | 1 | 996 | 670 | 326 | | | 2, 574 | 2. 58 |
| Dade | | 10 | 6, 760 | | 6, 708 | 52 | | 11, 385 | 1. 68 |
| Grundy | 1 | | 23, 401 | 19, 793 | 2, 108 | | 1, 500 | 47, 972 | 2. 05 |
| Henry | 16 | 33 | 180, 118 | 154, 457 | 19, 889 | 1, 823 | 3, 949 | 278, 986 | 1. 55 |
| Howard | 1 | | 1, 100 | 1, 050 | | 50 | | 1, 540 | 1. 40 |
| Jasper | | 3 | 720 | | 720 | | | 1, 340 | 1. 86 |
| Johnson | 2 | 14 | 12, 841 | 5, 140 | 7, 209 | 159 | 333 | 25, 247 | 1. 97 |
| Lafayette | 27 | 12 | 348, 670 | 321, 405 | 20, 783 | 3, 669 | 2, 813 | 557, 186 | 1. 60 |
| Linn | 1 | 7 | 6, 992 | | 6, 908 | 76 | 8 | 13, 140 | 1. 88 |
| Livingston | | 5 | 1, 381 | | 1, 356 | 25 | | 3, 251 | 2. 35 |
| Macon | 8 | 19 | 446, 396 | 419, 735 | 11, 528 | 2, 013 | 13, 120 | 550, 475 | 1. 23 |
| Montgomery | 2 | 6 | 12, 300 | 10, 520 | 1, 446 | 234 | 100 | 17, 449 | 1. 42 |
| Monroe | | 4 | 222 | | 222 | | | 345 | 1. 55 |
| Morgan | 1 | | 2, 000 | 1, 700 | 200 | 30 | 70 | 5, 000 | 2. 50 |
| Nodaway | | 13 | 7, 758 | | 7, 752 | 4 | 2 | 19, 275 | 2. 48 |
| Putnam | 1 | 18 | 83, 774 | 74, 913 | 6, 741 | | 2, 120 | 112, 089 | 1. 34 |
| Ralls | | 6 | 562 | | 562 | | | 1, 061 | 1. 89 |
| Randolph | 14 | 25 | 221, 463 | 162, 365 | 53, 287 | 2, 002 | 3, 809 | 285, 019 | 1. 29 |
| Ray | 7 | 8 | 220, 530 | 210, 635 | 5, 786 | 1, 929 | 2, 180 | 351, 153 | 1. 59 |
| Saint Clair | 1 | 9 | 6, 880 | 4, 085 | 2, 570 | 125 | 100 | 14, 885 | 2. 16 |
| Saline | | 10 | 2, 225 | | 2, 225 | | | 4, 861 | 2. 18 |
| Schuyler | | 4 | 770 | | 770 | | | 1, 013 | 1. 32 |
| Shelby | | 3 | 275 | | 275 | | | 588 | 2. 14 |
| Sullivan | | 2 | 805 | | 805 | | | 1, 176 | 1. 46 |
| Vernon | 5 | 9 | 39, 420 | 32, 650 | 5, 910 | 500 | 360 | 46, 506 | 1. 18 |

## LABOR AND WAGES AT MISSOURI COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mine. | ABOVE GROUND. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total average number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Total | 6,631 | 950 | 122 | $2.09 | 228 | 107 | $2.11 | 246 | 692 | $1.52 | 214 | 29 | $0.80 | 181 |
| Barton | 182 | 20 | 4 | 2.38 | 311 | 2 | 2.00 | 315 | 13 | 1.54 | 171 | 1 | 1.50 | 180 |
| Bates | 1,500 | 403 | 35 | 2.15 | 210 | 23 | 2.22 | 249 | 340 | 1.55 | 213 | 5 | 1.00 | 257 |
| Boone | 82 | 6 | 2 | 1.97 | 306 | | | | 4 | 1.19 | 236 | | | |
| Henry | 495 | 104 | 15 | 2.01 | 220 | 9 | 1.85 | 261 | 66 | 1.27 | 259 | 14 | 0.81 | 139 |
| Lafayette | 1,116 | 111 | 25 | 2.04 | 245 | 18 | 2.20 | 216 | 68 | 1.41 | 228 | | | |
| Macon | 1,075 | 74 | 5 | 2.40 | 275 | 13 | 2.45 | 295 | 52 | 1.73 | 223 | 4 | 0.51 | 215 |
| Randolph | 586 | 60 | 8 | 2.42 | 215 | 11 | 2.05 | 255 | 41 | 1.72 | 170 | | | |
| Ray | 819 | 58 | 13 | 2.00 | 222 | 15 | 2.03 | 243 | 28 | 1.50 | 223 | 2 | 0.75 | 220 |
| Vernon | 67 | 22 | 2 | 1.65 | 240 | 1 | 1.50 | 300 | 19 | 1.75 | 240 | | | |
| Other counties (*a*) | 709 | 92 | 13 | 1.79 | 207 | 15 | 1.82 | 210 | 61 | 1.45 | 175 | 3 | 0.58 | 178 |

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total average number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Total | 5,681 | 103 | $2.34 | 230 | 4,780 | $2.04 | 201 | 656 | $1.72 | 206 | 142 | $0.71 | 203 | $2,476,870 |
| Barton | 162 | 4 | 2.06 | 261 | 140 | 1.82 | 170 | 14 | 1.54 | 165 | 4 | 1.00 | 132 | 56,781 |
| Bates | 1,097 | 15 | 2.48 | 207 | 937 | 2.62 | 214 | 114 | 1.91 | 216 | 31 | 0.57 | 226 | 628,087 |
| Boone | 76 | 3 | 2.30 | 260 | 70 | 1.39 | 254 | 3 | 1.25 | 283 | | | | 31,635 |
| Henry | 391 | 10 | 2.29 | 217 | 312 | 1.86 | 216 | 62 | 1.58 | 239 | 7 | 1.08 | 189 | 183,454 |
| Lafayette | 1,005 | 19 | 2.10 | 231 | 916 | 1.84 | 215 | 70 | 1.57 | 212 | | | | 421,162 |
| Macon | 1,001 | 13 | 2.72 | 294 | 745 | 1.89 | 217 | 194 | 1.72 | 212 | 49 | 0.61 | 216 | 424,070 |
| Randolph | 526 | 9 | 2.45 | 207 | 427 | 2.28 | 164 | 67 | 1.85 | 155 | 23 | 0.89 | 177 | 205,869 |
| Ray | 761 | 13 | 2.23 | 230 | 652 | 1.93 | 176 | 76 | 1.79 | 193 | 20 | 1.00 | 175 | 274,101 |
| Vernon | 45 | 2 | 1.65 | 240 | 41 | 1.40 | 180 | 2 | 1.25 | 90 | | | | 20,775 |
| Other counties (*a*) | 617 | 15 | 2.35 | 206 | 540 | 1.85 | 189 | 54 | 1.61 | 204 | 8 | 0.59 | 219 | 230,936 |

## EXPENDITURES AT MISSOURI COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| Total | 99 | $61,403 | 97 | $60,964 | 2 | $439 | 6,730 | $2,538,273 | $181,218 | $107,867 | $2,827,358 | $18,779 | $2,846,137 |
| Adair and Audrain | 8 | 2,334 | 8 | 2,334 | | | 136 | 49,978 | 1,621 | 1,976 | 53,575 | | 53,575 |
| Barton | 3 | 1,771 | 3 | 1,771 | | | 185 | 58,552 | 3,766 | 3,950 | 66,268 | 100 | 66,368 |
| Bates | 11 | 5,946 | 11 | 5,946 | | | 1,511 | 634,033 | 66,918 | 25,551 | 726,502 | 7,611 | 734,113 |
| Boone | 1 | 300 | 1 | 300 | | | 83 | 31,935 | 1,828 | 1,378 | 35,141 | | 35,141 |
| Caldwell, Callaway, Cooper, and Grundy. | 2 | 1,320 | 2 | 1,320 | | | 164 | 58,920 | 5,874 | 4,427 | 69,221 | 100 | 69,321 |
| Henry | 10 | 5,731 | 10 | 5,731 | | | 505 | 189,185 | 15,870 | 13,710 | 218,765 | 500 | 219,265 |
| Howard and Johnson. | 1 | 250 | 1 | 250 | | | 75 | 11,378 | 320 | 886 | 12,584 | | 12,584 |
| Lafayette and Linn | 28 | 14,875 | 28 | 14,875 | | | 1,154 | 438,269 | 22,178 | 20,155 | 480,602 | 9,288 | 489,890 |
| Macon and Morgan | 14 | 11,650 | 13 | 11,350 | 1 | 300 | 1,107 | 439,420 | 23,355 | 15,406 | 478,181 | 1,000 | 479,181 |
| Montgomery and Putnam. | 7 | 6,855 | 7 | 6,855 | | | 306 | 110,202 | 3,524 | 1,188 | 114,914 | 180 | 115,094 |
| Randolph | 8 | 4,191 | 7 | 4,052 | 1 | 139 | 594 | 210,060 | 13,307 | 7,167 | 230,534 | | 230,534 |
| Ray | 5 | 5,580 | 5 | 5,580 | | | 824 | 279,681 | 17,857 | 6,705 | 304,243 | | 304,243 |
| Saint Clair and Vernon. | 1 | 600 | 1 | 600 | | | 86 | 26,660 | 4,800 | 5,368 | 36,828 | | 36,828 |

*a* Adair, Audrain, Caldwell, Callaway, Cooper, Grundy, Howard, Johnson, Linn, Montgomery, Morgan, Putnam, and Saint Clair.

VALUE OF AND POWER AT MISSOURI COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | | | POWER USED IN MINING. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | Steam boilers. | | Number of animals employed. |
| | Acres. | Value. | Acres. | Value. | | | | | | Number. | Horse power. | |
| Total | 24, 276 | $1, 732, 197 | 11, 641 | $685, 772 | $527, 654 | $716, 105 | $3, 661, 728 | $330, 565 | $3, 992, 293 | 89 | 2, 648 | 542 |
| Adair and Audrain | 390 | 8, 250 | 6 | 7, 200 | 13, 500 | 16, 000 | 44, 950 | 6, 300 | 51, 250 | 3 | 130 | 7 |
| Barton | 1, 665 | 89, 500 | 401 | 20, 040 | 25, 139 | 2, 250 | 136, 929 | 6, 400 | 143, 329 | 1 | [illegible] | 29 |
| Bates | 1, 012 | 75, 089 | 2, 857 | 212, 960 | 42, 001 | 225, 331 | 555, 381 | 75, 700 | 631, 081 | 22 | 525 | 164 |
| Boone | 100 | 6, 000 | 340 | 10, 600 | 3, 500 | 3, 300 | 23, 400 | 3, 000 | 26, 400 | ........ | ........ | 11 |
| Caldwell, Callaway, Cooper, and Grundy. | 164 | 42, 000 | 745 | 24, 400 | 22, 108 | 53, 492 | 142, 000 | 7, 200 | 149, 200 | 4 | 200 | 9 |
| Henry | 3, 085 | 140, 227 | 938 | 32, 880 | 35, 800 | 35, 161 | 244, 068 | 25, 030 | 269, 998 | 7 | 97 | 42 |
| Howard and Johnson. | 80 | 800 | 530 | 14, 100 | 750 | 7, 850 | 23, 500 | 1, 600 | 25, 100 | 2 | 60 | 5 |
| Lafayette and Linn | 4, 176 | 259, 169 | 2, 846 | 200, 650 | 107, 015 | 118, 838 | 685, 672 | 60, 150 | 745, 822 | 1 | 20 | 67 |
| Macon and Morgan | 9, 182 | 915, 674 | 160 | 3, 200 | 101, 000 | 102, 937 | 1, 122, 811 | 61, 400 | 1, 184, 211 | 21 | 605 | 97 |
| Montgomery and Putnam. | 1, 959 | 39, 288 | 100 | 2, 500 | 47, 249 | 74, 183 | 163, 220 | 10, 585 | 173, 805 | 5 | 140 | 13 |
| Randolph | 1, 225 | 42, 700 | 1, 065 | 47, 717 | 74, 917 | 33, 075 | 198, 409 | 35, 450 | 233, 859 | 12 | 510 | 54 |
| Ray | 818 | 90, 500 | 1, 058 | 82, 900 | 50, 825 | 38, 688 | 262, 913 | 32, 400 | 295, 313 | 10 | 267 | 28 |
| Saint Clair and Vernon. | 420 | 23, 000 | 595 | 26, 625 | 3, 850 | 5, 000 | 58, 475 | 4, 450 | 62, 925 | 1 | 30 | 16 |

## MONTANA.

The following description of the several coal fields in Montana has been compiled mainly from the report of the inspector of mines, Mr. G. C. Swallow:

### CUSTER COUNTY.

The Miles City coal field lies on the south of the Yellowstone and west of the Tongue river. The extent of this field is not definitely known. The Pumpkin Creek field, on the eastern branch of that stream, 60 miles south of Miles City, containing 1 bed 14 to 16 feet thick, besides several thin seams, is supplying a local demand. The Little Pumpkin Creek field, about 20 miles southwest of the field above mentioned, is said to contain a bed of good coal 12 feet thick. On the Powder river, near the Montana-Wyoming line, on the north side of the Yellowstone, east of the Tongue river, and on the west side of the Rosebud river, are coal fields of importance, insuring an abundant supply for all purposes in this county.

### YELLOWSTONE COUNTY.

The Bull Mountain coal field is the most noted deposit in this part of the state. It covers an area of some 50 square miles, embracing several seams, the most important being the Mammoth, which shows from 10 to 15 feet of workable lignite coal, a most valuable fuel in this vast prairie country. This field is somewhat remote from railroad communication, and is therefore worked only for local trade.

### FERGUS COUNTY.

There are several important coal fields in Fergus county, the Judith River, Plum Creek, Maiden, and Fort Maginnis fields. These extensive regions have been but little explored and worked, but enough has been done to show that they contain vast quantities of available bituminous coal, suitable for all ordinary purposes.

### GALLATIN COUNTY.

The only coal mines of importance in this county are those of the Northern Pacific Coal Company, about 12 miles east of Bozeman. 8 seams have here been explored, but 1 only, the Bonanza, with 4 feet of clean, hard coal, is workable.

### CASCADE COUNTY.

Cascade county is favored with a vast amount of excellent coal, well distributed over the county, including the Willow Creek, Belt Creek, Missouri and Sun Rivers, and the Muddy Creek fields, yielding some of the best grades of bituminous coal, suitable for coking, gas, steam, and domestic uses, and in some sections a block coal is obtained, which can be used raw in smelting furnaces. With advantageous location as to railroad facilities and exceptionally favorable conditions for mining, this county is by far the most important coal producer in the state.

### LEWIS AND CLARKE COUNTY.

Discoveries of coal have been made on the Sun river, some 12 miles above Fort Shaw; around the base of Haystack butte, on the South fork of Sun river; on the North fork of Sun river; on Flat creek; on the hills between Flat creek and the Dearborn river, near Eagle rock; at and near Dearborn, and near Mullan tunnel. The coals have not been much worked in any of these localities, but increasing demands will no doubt stimulate activity in this direction.

### CHOTEAU COUNTY.

Vast amounts of coal have been found in different parts of this large county, sufficient for an abundant local supply, and eventually for a large demand elsewhere. It is considered that the entire western end of Choteau is underlaid with good coal, but no accurate or approximate statements can be made as to the extent of the area.

### PARK COUNTY.

The coals of this county are abundant and of most excellent quality, and while belonging to the lignite formation, the product of some of the mines is true bituminous, and compares favorably with the coals of the Appalachian system. The Horr, the Livingston, and Rocky Fork mines are among the most important in the county, embracing the Cinnabar and Rocky Fork districts.

Coal is found also in Beaverhead, Missoula, and Meagher counties in the west and Dawson county in the east, but only small local banks exist for domestic requirements.

CLASSIFICATION OF COAL DISTRICTS IN MONTANA.

| DIVISIONS AND LOCAL DISTRICTS. | Counties. |
|---|---|
| Eastern: | |
| Glendive | Dawson. |
| Miles City | Custer. |
| Western: | |
| Musselshell | Fergus. |
| Judith | Do. |
| Bull Mountain | Yellowstone. |
| Rocky Fork | Park. |
| Gardner | Do. |
| Western—Continued. | |
| Medicine Lodge | Beaverhead. |
| Bozeman | Gallatin. |
| Sand Coulee | Cascade. |
| Milk River | Choteau. |
| Marias | Do. |
| Dearborn | Lewis and Clarke. |
| Missoula | Missoula. |

During the calendar year 1889 the total quantity of coal mined in Montana, as reported to the Eleventh Census, was 363,301 short tons, valued at $880,773, or $2.42 per ton, at the mines. The quantity reported to the Tenth Census as mined in Montana was but 224 tons. The quality and well distributed abundance of coals in this state seem to warrant greater development than has been made during the decade; but the vast extent of territory embraced within its limits and meager supply of railroad facilities account for this apparent inaction. Now that statehood has been assumed, a new impetus will be given all industries, and a greater rate of progress in the coal-mining industry during the next decade may be looked for.

COAL PRODUCT OF MONTANA IN 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | Total product of coal of all grades for year 1889. | DISPOSITION OF TOTAL PRODUCT. | | | | | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|
| | | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | Manufactured into coke. | | |
| Total | 363,301 | 314,372 | 10,755 | 2,162 | 5,436 | 30,576 | $880,773 | $2.42 |
| Cascade | 166,480 | 161,687 | 4,723 | 70 | | | 339,227 | 2.04 |
| Choteau | 820 | | 670 | 100 | 50 | | 2,160 | 2.63 |
| Custer | 3,470 | | 3,450 | 10 | 10 | | 9,129 | 2.63 |
| Dawson | 733 | | 733 | | | | 1,900 | 2.59 |
| Fergus | 460 | | 415 | 45 | | | 1,380 | 3.00 |
| Gallatin | 43,838 | 42,745 | | 329 | 764 | | 104,377 | 2.38 |
| Lewis and Clarke | 50 | | 50 | | | | 200 | 4.00 |
| Missoula | 150 | | 150 | | | | 450 | 3.00 |
| Park | 147,300 | 109,940 | 564 | 1,608 | 4,612 | 30,576 | 421,950 | 2.86 |

### LABOR AND WAGES AT MONTANA COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mine. | ABOVE GROUND. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total average number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Total | 848 | 171 | 9 | $5.28 | 251 | 38 | $3.58 | 252 | 123 | $2.50 | 240 | 1 | $2.00 | 300 |
| Cascade and Gallatin. | 397 | 87 | 5 | 3.90 | 211 | 19 | 3.43 | 262 | 63 | 2.39 | 252 | | | |
| Park | 451 | 84 | 4 | 6.50 | 300 | 19 | 3.74 | 242 | 60 | 2.63 | 227 | 1 | 2.00 | 300 |

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total average number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Total | 677 | 11 | $4.31 | 248 | 521 | $3.19 | 213 | 143 | $2.60 | 235 | 2 | $1.50 | 300 | $576,773 |
| Cascade and Gallatin. | 310 | 6 | 3.83 | 228 | 193 | 3.35 | 233 | 111 | 2.53 | 245 | | | | 281,518 |
| Park | 367 | 5 | 4.80 | 272 | 328 | 3.08 | 202 | 32 | 2.91 | 200 | 2 | 1.50 | 300 | 295,255 |

### EXPENDITURES AT MONTANA COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| Total | 9 | $10,765 | 9 | $10,765 | | | 857 | $587,538 | $52,098 | $7,038 | $646,674 | $3,000 | $649,674 |
| Cascade and Gallatin. | 6 | 7,710 | 6 | 7,710 | | | 403 | 289,228 | 22,818 | 1,038 | 313,084 | | 313,084 |
| Park | 3 | 3,055 | 3 | 3,055 | | | 454 | 298,310 | 29,280 | 6,000 | 333,590 | 3,000 | 336,590 |

### VALUE OF AND POWER AT MONTANA COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | | | POWER USED IN MINING. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | Steam boilers. | | Number of cylinders. | Other power. | | | | |
| | | | | | | | | | | | | | Motors. | | Machines. | | Number of animals employed. |
| | Acres. | Value. | Acres. | Value. | | | | | | Number. | Horse power. | | Number. | Horse power. | Number. | Kind. | |
| Total | 9,110 | $628,903 | 400 | $125,000 | $76,033 | $251,640 | $1,081,576 | $71,500 | $1,153,076 | 10 | 405 | 8 | 1 | 20 | 13 | Legg. | 69 |
| Cascade and Gallatin. | 4,750 | 262,303 | | | 39,033 | 98,640 | 399,976 | 38,000 | 437,976 | 7 | 265 | 2 | 1 | 20 | 13 | Legg. | 26 |
| Park | 4,360 | 366,600 | 400 | 125,000 | 37,000 | 153,000 | 681,600 | 33,500 | 715,100 | 3 | 140 | 6 | | | | | 43 |

## NEW MEXICO.

The following description of the coal fields of New Mexico is from the official publication of the bureau of immigration of that state:

Coal is found in Colfax, Santa Fe, Rio Arriba, San Juan, Socorro, Lincoln, Bernalillo, and Grant counties in beds from 1.5 to 16 feet in thickness, ranging from brown lignite to anthracite.

The Raton fields, an extension of the Colorado fields, embrace about 600,000 acres of the best bituminous coal, of good coking quality. Mines are from 4 to 6 miles from Raton; working veins are 3.5 feet thick at Blossburg, 9 feet thick at Leconte, and have a capacity of 500 tons per day. This coal has very little sulphur and a red ash.

The Santa Fe coal field covers 15,000 acres, bearing 4 distinct veins, 4 to 5 feet thick. The fields are about 2.5 miles from Cerrillos. The anthracite coal is hard, dense, and of brilliant luster, containing 87.71 per cent fixed carbon and 5 per cent ash. About 2 miles from the anthracite are bituminous veins, of which 17 are exposed. The worked veins are 4.5 feet thick, of free-burning coal, which is also manufactured into good coke, used by the copper smelters in the vicinity. In places anthracite and bituminous coal occur in the same mines, the heat of porphyritic dikes which traverse the country undoubtedly having caused the transfiguration from one species into another. Natural coke has been frequently found.

The Rio Arriba coal fields, underlying nearly the entire northern part of the county, have been opened at Monero and Amargo. They are an extension of the La Plata county (Colorado) deposits, of bituminous character, and extend over about 5,000 acres in this locality.

The San Juan coal fields are very extensive, covering at least 30,000 acres, but have not been worked on account of the distance from rail communication.

The Bernalillo fields cover almost the entire western portion of the county, and are mainly worked at Gallup, on the Atlantic and Pacific railroad. The coal is bituminous. In Tijeras cañon, east of the Rio Grande, south of the Sandia mountains, veins of bituminous coal 9 feet thick are worked. On the upper Puerco brown lignite 4 to 8 feet thick occurs.

The Socorro fields are worked at Carthage, 8 miles east of the Rio Grande. They cover about 23,000 acres, are of bituminous character, and excellent for coking. The Atchison, Topeka and Santa Fe Railway Company owns about 5,000 acres of the county, and produces excellent coke at San Antonio.

Grant County fields are opened near Silver City, bearing a semianthracite coal.

In Lincoln county coal has been found near White Oaks and Fort Stanton, but as yet there is not sufficient data available whereupon to base correct information.

### CLASSIFICATION OF COAL DISTRICTS IN NEW MEXICO.

| DISTRICTS. | County. | DISTRICTS. | County. |
|---|---|---|---|
| Northeastern: | | Central: | |
| Raton | Colfax. | Los Cerrillos | Santa Fe. |
| Northwestern: | | San Pedro | Socorro. |
| Aztec | San Juan. | Caballo | Sierra. |
| Gallup | Bernalillo. | White Oaks | Lincoln. |
| Monero | Rio Arriba. | | |

**No report of coal mining in New Mexico was made to the Tenth Census. The total output during the calendar year 1889, as reported to the Eleventh Census, was 486,943 short tons, valued at $872,628, or $1.79 per ton, at the mines. There were in operation 18 regular establishments, giving employment to 1,034 persons. The total wages paid was $605,268. Reports were also received from 11 local banks.**

### COAL PRODUCT OF NEW MEXICO IN 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | Total product of coal of all grades for year 1889. | DISPOSITION OF TOTAL PRODUCT. | | | | | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|
| | | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | Manufactured into coke. | | |
| Total | 486,943 | 466,557 | 5,421 | 2,582 | 6,383 | 6,000 | $872,628 | $1.79 |
| Bernalillo | 233,059 | 229,298 | 446 | 1,242 | 2,073 | ........ | 395,892 | 1.70 |
| Colfax | 151,464 | 145,660 | 2,050 | 554 | 3,200 | ........ | 201,027 | 1.33 |
| Lincoln | 1,255 | ........ | 1,255 | ........ | ........ | ........ | 3,138 | 2.50 |
| Rio Arriba | 13,650 | 13,150 | ........ | 200 | 300 | ........ | 24,843 | 1.82 |
| San Juan | 400 | ........ | 385 | 15 | ........ | ........ | 1,055 | 2.64 |
| Santa Fe | 34,870 | 26,505 | 1,085 | 470 | 810 | 6,000 | 74,666 | 2.14 |
| Sierra | 40 | 39 | ........ | 1 | ........ | ........ | 200 | 5.00 |
| Socorro | 52,205 | 51,905 | 200 | 100 | ........ | ........ | 171,807 | 3.29 |

### LABOR AND WAGES AT NEW MEXICO COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mine. | ABOVE GROUND. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total average number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Total | 1,015 | 157 | 13 | $3.27 | 208 | 26 | $2.88 | 231 | 112 | $2.37 | 214 | 6 | $1.07 | 187 |
| Bernalillo | 369 | 57 | 3 | 3.16 | 213 | 11 | 3.22 | 235 | 42 | 2.48 | 248 | 1 | 1.50 | 244 |
| Santa Fe | 103 | 41 | 10 | 3.30 | 207 | 5 | 2.65 | 201 | 26 | 2.35 | 209 | ........ | ........ | ........ |
| Other counties (*a*) | 543 | 59 | ........ | ........ | ........ | 10 | 2.60 | 242 | 44 | 2.23 | 185 | 5 | 0.95 | 176 |

*a* Colfax, Rio Arriba, Sierra, and Socorro counties.

LABOR AND WAGES AT NEW MEXICO COAL MINES IN 1889, BY COUNTIES—Continued.

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total average number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Total | 858 | 9 | $3.58 | 287 | 688 | $3.08 | 192 | 146 | $2.59 | 207 | 15 | $1.09 | 185 | $584,376 |
| Bernalillo | 312 | 5 | 3.62 | 292 | 239 | 3.09 | 241 | 65 | 2.89 | 237 | [illegible] | 1.00 | 235 | 266,833 |
| Santa Fe | 62 | 1 | 5.00 | 200 | 54 | 3.69 | 193 | 6 | 2.08 | 182 | 1 | 1.00 | 250 | 66,537 |
| Other counties (a) | 484 | 3 | 3.21 | 308 | 395 | 2.97 | 162 | 75 | 2.30 | 183 | 11 | 1.14 | 166 | 251,006 |

EXPENDITURES AT NEW MEXICO COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| Total | 19 | $20,892 | 19 | $20,892 | ........ | ........ | 1,034 | $605,268 | $103,300 | $62,643 | $771,211 | $7,360 | $778,571 |
| Bernalillo | 5 | 5,580 | 5 | 5,580 | ........ | ........ | 374 | 272,413 | 51,120 | 40,109 | 363,642 | ........ | 363,642 |
| Colfax, Rio Arriba, Sierra, and Socorro. | 10 | 12,192 | 10 | 12,192 | ........ | ........ | 553 | 263,198 | 43,445 | 19,957 | 326,600 | ........ | 326,600 |
| Santa Fe | 4 | 3,120 | 4 | 3,120 | ........ | ........ | 107 | 69,657 | 8,735 | 2,577 | 80,969 | 7,360 | 88,329 |

VALUE AND POWER AT NEW MEXICO COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | | | POWER USED IN MINING. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | Steam boilers. | | Other power. | | | |
| | | | | | | | | | | | | Motors. | | Number of machines. | Number of animals employed. |
| | Acres. | Value. | Acres. | Value. | | | | | | Number. | Horse power. | Number. | Horse power. | | |
| Total | 10,560 | $363,143 | 800 | $13,540 | $294,343 | $243,871 | $914,897 | $85,170 | $1,000,067 | 29 | 1,993 | 1 | 30 | 7 | 145 |
| Bernalillo | 1,160 | 66,260 | 640 | 10,340 | 114,658 | 146,265 | 337,523 | 40,100 | 377,623 | 10 | 530 | ........ | ........ | ........ | 58 |
| Colfax, Rio Arriba, Sierra, and Socorro. | 8,640 | 284,323 | ........ | ........ | 162,535 | 83,516 | 530,374 | 33,520 | 563,894 | 15 | 1,396 | 1 | 30 | 7 | 41 |
| Santa Fe | 760 | 12,560 | 160 | 3,200 | 17,150 | 14,090 | 47,000 | 11,550 | 58,550 | 4 | 67 | ........ | ........ | ........ | 46 |

*a* Colfax, Rio Arriba, Sierra, and Socorro counties.

## MICHIGAN.

In Michigan coal is mined in 6 counties, namely, Calhoun, Clinton, Eaton, Jackson, Huron, and Shiawassee, although this northern field, which is a detached deposit entirely isolated from the more important coal fields east of the Mississippi river, underlies the whole or portions of 11 counties in the southern central section of the state, including, in addition to those above named, Saginaw, Ionia, Montcalm, Gratiot, Isabella, Midland, Tuscola, Genesee, Ingham, Bay, and Livingston counties, covering an aggregate area of nearly 7,000 square miles.

Coal mining in this state has been unprofitable, the better coals of Pennsylvania and Ohio being delivered to points within the state at prices with which local coals can not compete. Recent analyses exhibit fixed carbon 45 and volatile combustible matter 49, showing a good steaming fuel, and much the greater portion of the output is disposed of to railroad companies and manufacturers for engine use.

Owing to the conditions above stated, the production has fallen off somewhat during 1889 as compared with the previous year. Prior to 1880 the aggregate output was about 500,000 short tons. The production reported to the Tenth Census for the year ended June 30, 1880, was 100,800 short tons, valued at $224,500 at the mines, an average of $2.23 per ton. The output for the year 1889, as reported to the census, was 67,431 short tons, valued at $115,011, or an average of $1.71 per ton, at the mines. The largest production for any year was in 1882, when 135,339 short tons were reported, since which there has been a gradual falling off.

The following table gives the total production of coal in 1889 and the disposition of the same:

### COAL PRODUCT OF MICHIGAN IN 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | MINES. | | Total product of coal of all grades for 1889. | DISPOSITION OF TOTAL PRODUCT. | | | | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|---|
| | Regular. | Local. | | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | | |
| Total | 6 | 6 | 67,431 | 53,104 | 8,289 | 821 | 5,217 | $115,011 | $1.71 |
| Calhoun | 1 | | 350 | 175 | 150 | 10 | 15 | 650 | 1.86 |
| Clinton | | 1 | 364 | | 361 | 3 | | 618 | 1.70 |
| Eaton | | 3 | 812 | | 810 | 2 | | 1,131 | 1.39 |
| Jackson | 4 | 1 | 47,731 | 37,295 | 6,938 | 796 | 2,702 | 83,589 | 1.75 |
| Huron | | 1 | 40 | | 30 | 10 | | 100 | 2.50 |
| Shiawassee | 1 | | 18,134 | 15,634 | | | 2,500 | 28,923 | 1.59 |

The following table gives the average wages paid for labor, both above and below ground, total employés at the mines, and total amount expended for labor:

### LABOR AND WAGES AT MICHIGAN COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mines. | ABOVE GROUND. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Total | 261 | 46 | 7 | $2.10 | 199 | 11 | $1.91 | 213 | 28 | $1.92 | 249 |
| Calhoun and Shiawassee | 83 | 11 | 2 | 2.25 | 175 | 3 | 1.87 | 300 | 6 | 1.29 | 258 |
| Jackson | 178 | 35 | 5 | 2.05 | 209 | 8 | 1.94 | 181 | 22 | 2.10 | 246 |

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Total | 215 | 4 | $2.34 | 218 | 191 | $1.74 | 184 | 10 | $1.69 | 216 | 10 | $0.87 | 300 | $90,124 |
| Calhoun and Shiawassee | 72 | 1 | 2.50 | 300 | 55 | 1.73 | 277 | 6 | 1.70 | 300 | 10 | 0.87 | 300 | 37,204 |
| Jackson | 143 | 3 | 2.25 | 190 | 136 | 1.75 | 146 | 4 | 1.63 | 90 | | | | 52,920 |

The following table shows the office force employed and the amount expended in coal mines during the year 1889:

### EXPENDITURES AT MICHIGAN COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | TOTAL OFFICE FORCE. | | Total number of employés. | Total amount of wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Total of all expenditures. |
|---|---|---|---|---|---|---|---|---|
| | Number. | Amount of wages. | | | | | | |
| Total | 4 | $3,470 | 265 | $93,594 | $9,085 | $11,035 | $113,714 | $113,714 |
| Calhoun and Shiawassee | 1 | 1,500 | 84 | 38,704 | 3,885 | 537 | 43,126 | 43,126 |
| Jackson | 3 | 1,970 | 181 | 54,890 | 5,200 | 10,498 | 70,588 | 70,588 |

The following table gives the value of mines and improvements, description of power used, and number of animals employed:

VALUE OF AND POWER AT MICHIGAN COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | | | POWER USED IN MINING. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | Steam boilers. | | Cylinders. | | Number of animals. |
| | Acres. | Value. | Acres. | Value. | | | | | | Number. | Horse power. | Number. | Size. (Inches.) | |
| Total | 142 | $7,800 | 480 | $9,600 | $7,800 | $12,750 | $37,950 | $11,700 | $49,650 | 12 | 535 | 9 | .......... | 22 |
| Calhoun and Shiawassee. | 142 | 7,800 | .......... | .......... | 5,000 | 2,000 | 14,800 | 3,750 | 18,550 | 5 | 145 | 2 | 8 x 12<br>10 x 16 | 10 |
| Jackson | .......... | .......... | 480 | 9,600 | 2,800 | 10,750 | 23,150 | 7,950 | 31,100 | 7 | 390 | 7 | .......... | 12 |

## OHIO.

The great Appalachian coal field extends over the eastern portion of the state of Ohio, and covers an area of about 10,000 square miles. The western border passes through the counties of Trumbull, Geauga, Portage, Summit, Medina, Wayne, Holmes, Knox, Licking, Perry, Hocking, Vinton, Jackson, Pike, and Scioto.

The coal measures of the state are divided into 3 series, namely, the lower measures, the barren measures, and the upper measures, but only the upper and lower measures contain workable veins. The principal seams are numbered from 1 to 8, beginning at the lowest or Sharon bed and ending with the Pittsburg bed, at the bottom of the upper measures. The lower measures furnish the greater portion of the coal mined in the state, the most important seam of which is the great No. 6, or Hocking Valley. The coals now being worked are mainly from the seams designated as Nos. 1, 2, 6, 7, and 8. The varieties are, however, better known to the trade by the names of the local districts producing them.

The following is a list of counties, mine inspectors' districts, and local districts in the state of Ohio in which commercial mines are in operation:

| Mine inspectors' district. | COUNTIES. | Local district. | Subdistrict. |
|---|---|---|---|
| 1 | Gallia, except Cheshire township. | Ohio valley. | |
| 2 | Gallia, Cheshire township | ....do. | |
| 2 | Washington | ....do | Macksburg. |
| 2 | Do | ....do | Coal run. |
| 1 | Lawrence | ....do | Ironton. |
| 2 | Jefferson, except Spring township. | ....do | Yellow creek.<br>Steubenville.<br>Dillonvale. |
| 4 | Jefferson, Spring township | ....do | Bergholz. |
| 2 | Meigs | ....do | Pomeroy. |
| 2 | Belmont | ....do | Wheeling creek. |
| 2 | Do | ....do | Bellaire. |
| 2 | Morgan | ....do | Muskingum. |
| 5 | Medina | Medina. | |
| 4 | Coshocton | Tuscarawas valley | Do. |
| 4 | Do | ....do | White Woman. |
| 4 | Tuscarawas | Tuscarawas. | |
| 4 | Holmes | ....do. | |
| 5 | Wayne | ....do | Killbuck. |
| 5 | Do | ....do | Wooster. |
| 5 | Summit | Akron. | |
| 5 | Stark | Tuscarawas valley | Massillon. |
| 5 | Do | ....do | Wheeling and Lake Erie. |
| 1 | Vinton | Hocking | Vinton. |
| 3 | Perry | ....do | Muskingum. |
| 1 | Hocking | ....do | Hocking. |
| 3 | Athens, except Troy township. | ....do | Nelsonville. |
| 2 | Athens, Troy township | ....do | Do. |
| 5 | Mahoning | Mahoning valley. | |
| 5 | Trumbull | ....do | Brier hill. |
| 5 | Portage | ....do | Palmyra. |
| 2 | Guernsey | Cambridge | Quaker City. |
| 2 | Do | ....do | Trail run. |
| 4 | Carroll | Connotton valley. | |
| 2 | Harrison | ....do. | |
| 2 | Noble, except Brookfield township. | Macksburg. | |
| 3 | Noble, Brookfield township | ....do. | |
| 2 | Jackson | Jackson. | |
| 3 | Muskingum | Muskingum valley. | |
| 5 | Columbiana, northern part | Salineville. | |
| 4 | Columbiana, southern part | ....do. | |

The coal beds of Ohio, like all others of the Appalachian field, embrace all the varieties of bituminous steam, coking, gas, and cannel coal. The larger part of the product is adapted for coking and steam, although the block coals of the Hocking valley and other sections have been extensively used for blast furnaces, but are now being superseded for that purpose by the Connellsville cokes. Very little Ohio coal is used for gas manufacture, owing to the convenience of obtaining the better gas coals of Pennsylvania. The cannels are found, as is usual, in pockets, varying in thickness and extent, but never of any great economic value, the low per cent of volatile matter detracting from their efficiency in the manufacture and enrichment of gas; hence they have attained only a local importance.

The total quantity of coal produced in Ohio during the year ended June 30, 1880, as reported to the Tenth Census, was 6,008,595 short tons, valued at $7,719,667, an average of $1.28 per ton, at the mines. During the year 1889 the total production, as reported to the Eleventh Census, was 9,976,787 short tons, valued at $9,355,400, an average of $0.94 per ton, at the mines.

The following table gives the number of regular and local mines worked, the total product of coal, and the disposition of the same:

COAL PRODUCT OF OHIO IN 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | MINES. |  | Total product of coal of all grades for 1889. | DISPOSITION OF TOTAL PRODUCT. |  |  |  |  | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|---|---|
|  | Regular. | Local. |  | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | Manufactured into coke. |  |  |
| Total | 323 | 1,745 | 9,976,787 | 8,566,223 | 1,196,872 | 50,271 | 93,952 | 69,469 | $9,355,400 | $0.94 |
| Athens | 29 | 31 | 1,224,186 | 1,102,670 | 70,933 | 4,273 | 7,288 | 39,022 | 994,344 | 0.81 |
| Belmont | 24 | 171 | 641,862 | 456,221 | 175,396 | 3,299 | 1,946 | 5,000 | 558,333 | 0.87 |
| Carroll | 6 | 39 | 351,782 | 337,393 | 14,101 | 88 | 200 | ... | 261,813 | 0.74 |
| Columbiana | 19 | 65 | 596,824 | 542,665 | 49,388 | 2,492 | 2,279 | ... | 471,945 | 0.79 |
| Coshocton | 8 | 32 | 166,599 | 112,130 | 53,691 | 446 | 332 | ... | 163,659 | 0.98 |
| Gallia | 1 | 104 | 23,208 | 14,339 | 7,658 | 1,211 | ... | ... | 24,068 | 1.04 |
| Guernsey | 10 | 98 | 362,168 | 328,568 | 26,552 | 3,112 | 3,936 | ... | 313,480 | 0.87 |
| Harrison | 2 | 109 | 33,724 | 800 | 31,817 | 1,107 | ... | ... | 41,028 | 1.22 |
| Hocking | 10 | 32 | 845,049 | 820,294 | 10,757 | 523 | 13,475 | ... | 683,551 | 0.81 |
| Holmes | ... | 20 | 9,423 | ... | 9,272 | 146 | 5 | ... | 13,037 | 1.38 |
| Jackson | 36 | 55 | 926,874 | 823,269 | 94,241 | 3,009 | 6,355 | ... | 953,696 | 1.03 |
| Jefferson | 16 | 92 | 271,830 | 173,260 | 90,287 | 3,068 | 2,268 | 2,947 | 273,075 | 1.00 |
| Lawrence | 6 | 87 | 102,656 | 44,432 | 57,872 | 352 | ... | ... | 106,269 | 1.04 |
| Mahoning | 8 | 24 | 240,563 | 187,321 | 23,227 | 2,798 | 4,717 | 22,500 | 280,406 | 1.17 |
| Medina | 4 | 2 | 136,061 | 125,759 | 2,975 | 1,385 | 5,942 | ... | 158,003 | 1.16 |
| Meigs | 11 | 61 | 220,277 | 103,301 | 111,698 | 3,132 | 2,146 | ... | 223,614 | 1.02 |
| Monroe | 1 | 49 | 20,725 | 16,000 | 4,246 | 479 | ... | ... | 34,060 | 1.64 |
| Morgan | ... | 51 | 8,060 | ... | 7,662 | 398 | ... | ... | 10,502 | 1.30 |
| Muskingum | 15 | 132 | 214,005 | 133,589 | 79,254 | 554 | 608 | ... | 212,873 | 0.99 |
| Noble | 3 | 160 | 38,400 | 10,200 | 26,250 | 1,950 | ... | ... | 44,039 | 1.15 |
| Perry | 38 | 72 | 1,565,786 | 1,506,282 | 51,313 | 3,754 | 4,437 | ... | 1,317,963 | 0.84 |
| Portage | 2 | ... | 78,117 | 73,728 | 2,641 | 598 | 1,150 | ... | 99,213 | 1.27 |
| Stark | 26 | 41 | 851,994 | 782,466 | 41,541 | 5,502 | 22,485 | ... | 1,073,703 | 1.26 |
| Summit | 4 | 4 | 50,726 | 36,152 | 11,645 | 857 | 2,072 | ... | 92,723 | 1.83 |
| Trumbull | 7 | 6 | 108,120 | 101,270 | 4,193 | 1,417 | 1,240 | ... | 176,934 | 1.64 |
| Tuscarawas | 27 | 114 | 683,505 | 562,060 | 113,886 | 2,468 | 5,091 | ... | 544,524 | 0.80 |
| Vinton | 6 | 64 | 102,040 | 85.202 | 14,756 | 1,262 | 820 | ... | 104,972 | 1.03 |
| Washington | 2 | 24 | 18.045 | 11,374 | 6,270 | 341 | 60 | ... | 19,684 | 1.09 |
| Wayne | 2 | 6 | 84,178 | 75,478 | 3,350 | 250 | 5,100 | ... | 103,883 | 1.23 |

The table on the following page shows the labor employed at the mines, both above and below ground, the average wages paid per day, and the amount of wages paid during the year 1889.

## LABOR AND WAGES AT OHIO COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mines. | ABOVE GROUND. | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Total | 19, 343 | 2, 058 | 221 | $2. 28 | 244 | 334 | $1. 91 | 235 | 1, 420 | $1. 51 | 192 | 83 | $0. 77 | 187 |
| Athens | 2, 228 | 262 | 24 | 2. 62 | 282 | 38 | 2. 04 | 239 | 189 | 1. 61 | 201 | 11 | 0. 96 | 179 |
| Belmont | 1, 100 | 111 | 19 | 2. 07 | 228 | 9 | 1. 82 | 244 | 82 | 1. 57 | 209 | 1 | 0. 75 | 200 |
| Carroll | 565 | 42 | 6 | 2. 32 | 160 | 4 | 1. 94 | 207 | 29 | 1. 60 | 217 | 3 | 0. 66 | 192 |
| Columbiana | 955 | 113 | 7 | 2. 16 | 260 | 5 | 1. 75 | 208 | 96 | 1. 54 | 249 | 5 | 0. 86 | 200 |
| Coshocton | 290 | 31 | 4 | 2. 08 | 256 | 1 | 2. 00 | 210 | 24 | 1. 58 | 200 | 2 | 0. 78 | 193 |
| Gallia | 34 | 3 | ....... | ....... | ....... | ....... | ....... | ....... | 3 | 1. 25 | 205 | ....... | ....... | ....... |
| Guernsey | 668 | 90 | 8 | 2. 44 | 254 | 18 | 2. 30 | 167 | 62 | 1. 63 | 183 | 2 | 0. 75 | 156 |
| Harrison | 8 | ....... | ....... | ....... | ....... | ....... | ....... | ....... | ....... | ....... | ....... | ....... | ....... | ....... |
| Hocking | 1, 187 | 65 | 11 | 2. 63 | 241 | 19 | 2. 33 | 221 | 34 | 1. 50 | 151 | 1 | 0. 50 | 180 |
| Jackson | 2, 251 | 190 | 24 | 2. 13 | 260 | 40 | 1. 73 | 254 | 120 | 1. 38 | 170 | 6 | 0. 79 | 195 |
| Jefferson | 511 | 82 | 6 | 2. 08 | 245 | 13 | 1. 89 | 260 | 61 | 1. 38 | 213 | 2 | 0. 75 | 174 |
| Lawrence | 232 | 33 | 4 | 2. 12 | 299 | 6 | 1. 48 | 277 | 23 | 1. 17 | 254 | ....... | ....... | ....... |
| Mahoning | 636 | 51 | 6 | 2. 13 | 251 | 12 | 1. 86 | 247 | 32 | 1. 33 | 237 | 1 | 0. 85 | 232 |
| Medina | 379 | 30 | 2 | 3. 50 | 300 | 11 | 1. 89 | 319 | 15 | 1. 53 | 179 | 2 | 0. 88 | 205 |
| Meigs | 567 | 108 | 6 | 1. 98 | 240 | 16 | 1. 68 | 212 | 81 | 1. 17 | 154 | 5 | 0. 47 | 155 |
| Monroe | 29 | 6 | 1 | 1. 75 | 300 | 2 | 2. 00 | 300 | 3 | 1. 25 | 300 | ....... | ....... | ....... |
| Muskingum | 304 | 30 | 7 | 2. 36 | 259 | 3 | 1. 89 | 219 | 20 | 1. 57 | 172 | ....... | ....... | ....... |
| Noble | 43 | 7 | 2 | 1. 50 | 333 | 1 | 1. 50 | 20 | 4 | 1. 13 | 250 | ....... | ....... | ....... |
| Perry | 3, 056 | 324 | 33 | 2. 26 | 196 | 32 | 1. 90 | 183 | 239 | 1. 70 | 164 | 20 | 0. 81 | 151 |
| Portage | 179 | 9 | 2 | 2. 62 | 300 | 4 | 1. 93 | 191 | 3 | 1. 40 | 160 | ....... | ....... | ....... |
| Stark | 1, 975 | 199 | 18 | 2. 20 | 260 | 51 | 1. 95 | 240 | 127 | 1. 48 | 190 | 3 | 0. 75 | 160 |
| Summit | 170 | 28 | 5 | 2. 21 | 250 | 6 | 1. 97 | 312 | 13 | 1. 50 | 206 | 4 | 0. 65 | 208 |
| Trumbull | 388 | 40 | 7 | 2. 44 | 220 | 11 | 1. 67 | 255 | 22 | 1. 28 | 147 | ....... | ....... | ....... |
| Tuscarawas | 1, 061 | 136 | 14 | 2. 19 | 225 | 20 | 2. 01 | 233 | 88 | 1. 50 | 203 | 14 | 0. 71 | 241 |
| Vinton | 256 | 37 | 2 | 2. 13 | 200 | 6 | 1. 42 | 262 | 28 | 1. 21 | 227 | 1 | 0. 60 | 265 |
| Washington | 23 | 8 | 1 | 2. 00 | 267 | 2 | 1. 75 | 189 | 5 | 1. 42 | 245 | ....... | ....... | ....... |
| Wayne | 248 | 23 | 2 | 2. 75 | 333 | 4 | 2. 06 | 339 | 17 | 1. 58 | 157 | ....... | ....... | ....... |

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Total | 17, 285 | 221 | $2. 32 | 245 | 14, 733 | $1. 95 | 181 | 1, 955 | $1. 63 | 185 | 376 | $0. 71 | 181 | $6, 730, 778 |
| Athens | 1, 966 | 15 | 2. 42 | 263 | 1, 741 | 1. 95 | 183 | 173 | 1. 62 | 196 | 37 | 0. 74 | 183 | 790, 035 |
| Belmont | 989 | 15 | 2. 13 | 223 | 812 | 1. 94 | 196 | 154 | 1. 62 | 191 | 8 | 0. 56 | 201 | 398, 586 |
| Carroll | 523 | 7 | 2. 46 | 175 | 467 | 2. 02 | 183 | 35 | 1. 80 | 202 | 14 | 0. 65 | 156 | 208, 890 |
| Columbiana | 842 | 17 | 2. 34 | 257 | 764 | 1. 73 | 238 | 52 | 1. 64 | 221 | 9 | 0. 84 | 229 | 380, 732 |
| Coshocton | 259 | 7 | 1. 93 | 275 | 236 | 1. 76 | 208 | 14 | 1. 58 | 227 | 2 | 1. 00 | 210 | 104, 056 |
| Gallia | 31 | 1 | 1. 75 | 242 | 24 | 1. 50 | 205 | 6 | 1. 20 | 242 | ....... | ....... | ....... | 10, 315 |
| Guernsey | 578 | 8 | 2. 24 | 243 | 468 | 2. 12 | 175 | 87 | 1. 84 | 164 | 15 | 0. 76 | 144 | 227, 713 |
| Harrison | 8 | ....... | ....... | ....... | 8 | 1. 69 | 100 | ....... | ....... | ....... | ....... | ....... | ....... | 1, 350 |
| Hocking | 1, 122 | 6 | 2. 64 | 239 | 948 | 2. 32 | 213 | 136 | 2. 00 | 213 | 32 | 0. 71 | 245 | 571, 763 |
| Jackson | 2, 061 | 29 | 2. 29 | 267 | 1, 618 | 2. 00 | 165 | 397 | 1. 41 | 170 | 17 | 0. 52 | 186 | 706, 361 |
| Jefferson | 429 | 9 | 2. 52 | 251 | 344 | 1. 99 | 106 | 69 | 1. 53 | 159 | 7 | 0. 80 | 121 | 201, 449 |
| Lawrence | 199 | 2 | 2. 00 | 200 | 182 | 1. 39 | 232 | 15 | 1. 13 | 242 | ....... | ....... | ....... | 74, 278 |
| Mahoning | 585 | 7 | 2. 34 | 244 | 521 | 1. 46 | 232 | 38 | 1. 66 | 228 | 19 | 0. 78 | 217 | 214, 390 |
| Medina | 349 | 4 | 2. 75 | 300 | 320 | 1. 61 | 170 | 17 | 1. 83 | 163 | 8 | 0. 64 | 166 | 116, 244 |
| Meigs | 459 | 8 | 2. 03 | 221 | 346 | 1. 90 | 161 | 76 | 1. 27 | 204 | 29 | 0. 89 | 172 | 152, 620 |
| Monroe | 23 | 1 | 2. 00 | 300 | 20 | 2. 50 | 300 | 2 | 1. 25 | 300 | ....... | ....... | ....... | 19, 100 |
| Muskingum | 274 | 7 | 1. 82 | 239 | 244 | 1. 80 | 182 | 17 | 1. 67 | 185 | 6 | 0. 72 | 181 | 91, 360 |
| Noble | 36 | 2 | 1. 95 | 258 | 31 | 1. 50 | 190 | 3 | 1. 00 | 227 | ....... | ....... | ....... | 12, 449 |
| Perry | 2, 732 | 18 | 2. 53 | 251 | 2, 448 | 2. 16 | 148 | 209 | 1. 78 | 160 | 57 | 0. 73 | 145 | 952, 987 |
| Portage | 170 | 1 | 3. 50 | 275 | 145 | 1. 75 | 178 | 22 | 1. 75 | 180 | 2 | 0. 75 | 186 | 57, 549 |
| Stark | 1, 776 | 21 | 2. 49 | 240 | 1, 479 | 2. 10 | 177 | 207 | 1. 77 | 179 | 69 | 0. 65 | 171 | 707, 736 |
| Summit | 142 | 11 | 2. 02 | 227 | 105 | 1. 82 | 208 | 20 | 1. 95 | 211 | 6 | 0. 68 | 201 | 63, 095 |
| Trumbull | 348 | 5 | 2. 61 | 287 | 299 | 1. 60 | 157 | 29 | 1. 48 | 161 | 15 | 0. 91 | 198 | 108, 520 |
| Tuscarawas | 925 | 16 | 2. 35 | 215 | 789 | 1. 86 | 215 | 109 | 1. 66 | 199 | 11 | 0. 64 | 210 | 403, 726 |
| Vinton | 219 | 3 | 2. 10 | 262 | 160 | 1. 56 | 205 | 48 | 1. 34 | 195 | 8 | 0. 45 | 226 | 74, 411 |
| Washington | 15 | ....... | ....... | ....... | 14 | 1. 91 | 231 | 1 | 1. 56 | 180 | ....... | ....... | ....... | 9, 368 |
| Wayne | 225 | 1 | 2. 00 | 200 | 200 | 1. 75 | 165 | 19 | 1. 84 | 158 | 5 | 0. 60 | 150 | 71, 695 |

The following table shows the office force employed and the amount expended during the year 1889:

### EXPENDITURES AT OHIO COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| Total | 248 | $161,826 | 240 | $159,072 | 8 | $2,754 | 19,591 | $6,892,604 | $568,020 | $712,792 | $8,173,416 | $58,767 | $8,232,183 |
| Athens | 40 | 25,107 | 39 | 24,807 | 1 | 300 | 2,268 | 815,142 | 56,232 | 73,906 | 945,280 | | 945,280 |
| Belmont | 22 | 12,934 | 20 | 11,910 | 2 | 1,024 | 1,122 | 411,520 | 55,140 | 41,832 | 508,492 | 1,412 | 509,904 |
| Carroll | 5 | 3,120 | 5 | 3,120 | | | 570 | 212,010 | 11,730 | 20,250 | 243,990 | 2,000 | 245,990 |
| Columbiana | 5 | 3,780 | 5 | 3,780 | | | 960 | 384,512 | 22,496 | 39,608 | 446,616 | 23,500 | 470,116 |
| Coshocton | 7 | 6,540 | 7 | 6,540 | | | 297 | 110,596 | 5,171 | 11,863 | 127,630 | | 127,630 |
| Gallia and Guernsey | 10 | 6,160 | 9 | 6,010 | 1 | 150 | 712 | 244,188 | 14,256 | 32,375 | 290,819 | | 290,819 |
| Harrison | | | | | | | 8 | 1,350 | 100 | | 1,450 | | 1,450 |
| Hocking | 13 | 10,075 | 12 | 9,835 | 1 | 240 | 1,200 | 581,838 | 50,035 | 30,401 | 662,274 | | 662,274 |
| Jackson | 34 | 17,955 | 33 | 17,5[illegible] | 1 | 420 | 2,285 | 724,316 | 54,165 | 51,029 | 829,510 | | 829,510 |
| Jefferson | 7 | 4,840 | 6 | 4,320 | 1 | 520 | 518 | 206,289 | 20,957 | 11,750 | 238,996 | | 238,996 |
| Lawrence | 3 | 1,358 | 3 | 1,358 | | | 235 | 75,636 | 3,200 | 3,604 | 82,440 | | 82,440 |
| Mahoning | 7 | 3,515 | 7 | 3,515 | | | 643 | 217,905 | 17,341 | 27,017 | 262,263 | 305 | 262,568 |
| Medina | 2 | 2,100 | 2 | 2,100 | | | 381 | 118,344 | 10,221 | 16,085 | 144,650 | | 144,650 |
| Meigs and Monroe | 12 | 7,640 | 12 | 7,640 | | | 608 | 179,360 | 24,692 | 23,228 | 227,280 | | 227,280 |
| Muskingum | 3 | 2,400 | 3 | 2,400 | | | 307 | 93,760 | 6,272 | 7,425 | 107,457 | | 107,457 |
| Noble | | | | | | | 43 | 12,449 | 580 | 300 | 13,329 | | 13,329 |
| Perry | 25 | 14,317 | 25 | 14,317 | | | 3,081 | 967,304 | 60,409 | 102,368 | 1,130,081 | 4,000 | 1,134,081 |
| Portage | | | | | | | 179 | 57,549 | 3,296 | 27,645 | 88,490 | | 88,490 |
| Stark | 24 | 20,350 | 24 | 20,350 | | | 1,999 | 728,086 | 91,899 | 93,524 | 913,509 | 25,015 | 938,524 |
| Summit | 3 | 2,700 | 3 | 2,700 | | | 173 | 65,795 | 5,538 | 37,639 | 108,972 | 150 | 109,122 |
| Trumbull | 6 | 4,400 | 6 | 4,400 | | | 394 | 112,920 | 7,603 | 17,609 | 138,132 | | 138,132 |
| Tuscarawas | 7 | 6,120 | 7 | 6,120 | | | 1,068 | 409,846 | 38,685 | 26,842 | 475,373 | 2,385 | 477,758 |
| Vinton | 7 | 3,055 | 7 | 3,055 | | | 263 | 77,466 | 3,287 | 7,791 | 88,544 | | 88,544 |
| Washington | 2 | 300 | 1 | 200 | 1 | 100 | 25 | 9,668 | 1,465 | 305 | 11,438 | | 11,438 |
| Wayne | 4 | 3,060 | 4 | 3,060 | | | 252 | 74,755 | 3,250 | 8,396 | 86,401 | | 86,401 |

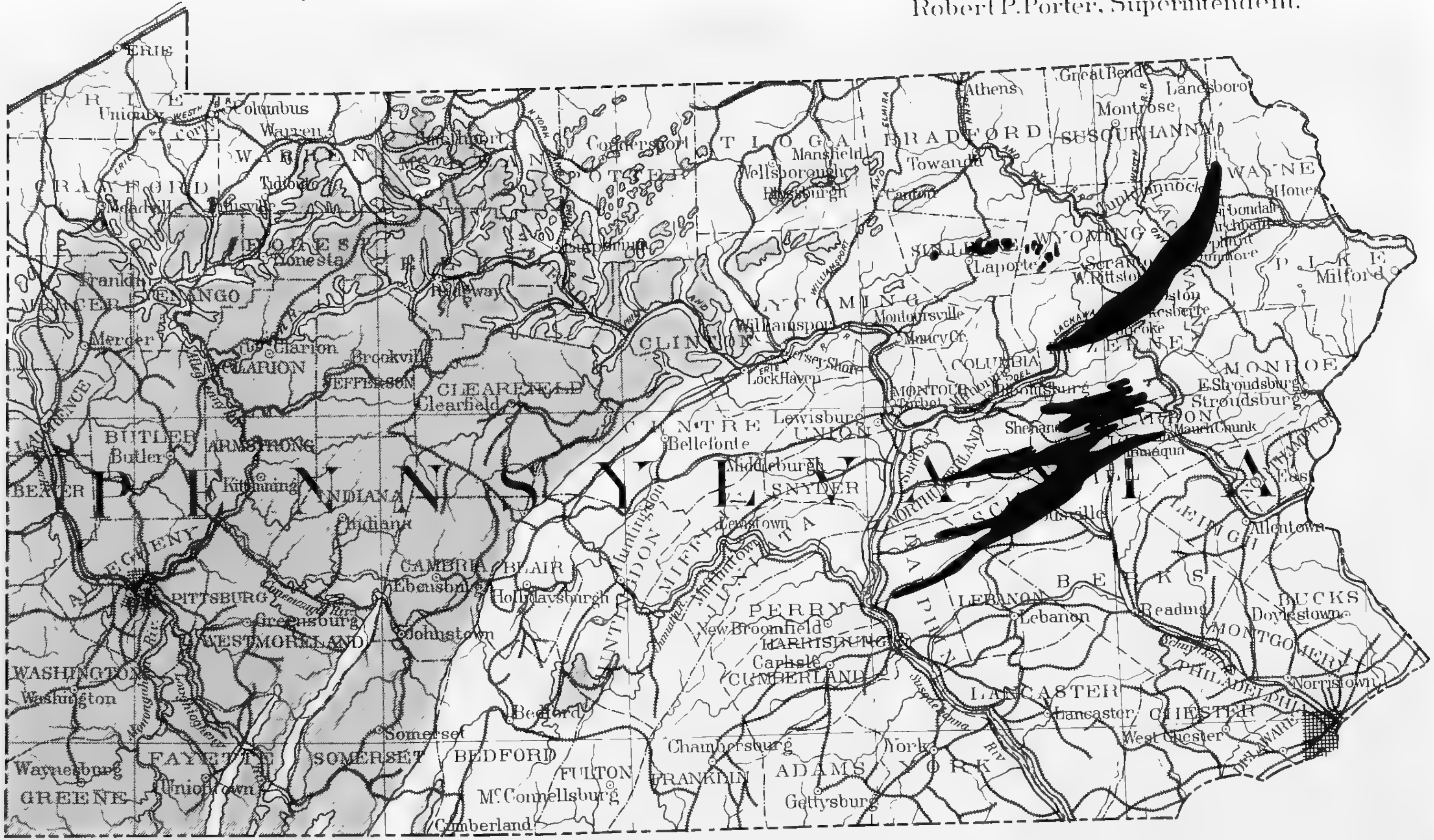
The following table gives the value of the mines and improvements and the kind of power used in mining:

### VALUE OF AND POWER AT OHIO COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | | | POWER USED IN MINING. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | Steam boilers. | | Number of cylinders. | Number of animals. |
| | Acres. | Value. | Acres. | Value. | | | | | | Number. | Horse power. | | |
| Total | 66,697 | $6,329,766 | 38,201 | $2,697,874 | $2,270,971 | $1,730,656 | $13,029,267 | $988,969 | $14,018,236 | 300 | 10,342 | 257 | 2,127 |
| Athens | 11,522 | 1,147,607 | 4,785 | 314,500 | 409,430 | 212,673 | 2,084,210 | 110,829 | 2,195,039 | 32 | 1,246 | 33 | 217 |
| Belmont | 2,903 | 154,230 | 4,515 | 208,975 | 103,100 | 96,539 | 562,844 | 69,900 | 632,744 | 9 | 240 | 8 | 169 |
| Carroll | 311 | 6,550 | 630 | 51,000 | 16,705 | 14,540 | 88,795 | 55,500 | 144,295 | 1 | 75 | | 53 |
| Columbiana | 1,167 | 37,900 | 2,443 | 158,775 | 78,300 | 51,050 | 326,025 | 36,800 | 362,825 | 13 | 640 | 7 | 107 |
| Coshocton | 825 | 41,283 | 786 | 56,300 | 68,358 | 9,925 | 175,866 | 12,450 | 188,316 | | | | 33 |
| Gallia and Guernsey | 1,878 | 51,660 | 1,666 | 122,000 | 47,600 | 139,875 | 361,135 | 33,250 | 394,385 | 17 | 703 | 16 | 93 |
| Harrison | 115 | 4,600 | | | 700 | 125 | 5,425 | 2,800 | 8,225 | | | | 1 |
| Hocking | 2,627 | 275,000 | 3,920 | 302,350 | 84,200 | 234,134 | 895,684 | 68,650 | 964,334 | 27 | 980 | 16 | 146 |
| Jackson | 7,451 | 1,025,385 | 1,909 | 136,186 | 237,275 | 157,466 | 1,556,312 | 88,145 | 1,644,457 | 30 | 1,159 | 36 | 194 |
| Jefferson | 8,281 | 1,727,160 | 980 | 74,500 | 248,750 | 172,555 | 2,222,965 | 30,975 | 2,253,940 | 10 | 269 | 6 | 66 |
| Lawrence | 1,460 | 33,400 | 160 | 16,000 | 8,000 | 7,000 | 64,400 | 8,050 | 72,450 | | | | 39 |
| Mahoning | 794 | 80,400 | 1,424 | 108,920 | 51,602 | 30,460 | 271,382 | 21,100 | 292,482 | 14 | 359 | 13 | 42 |
| Medina | | | 400 | 49,500 | 27,800 | 15,000 | 92,300 | 21,000 | 113,300 | 10 | 255 | 5 | 41 |
| Meigs and Monroe | 993 | 64,670 | 1,050 | 72,500 | 82,000 | 71,950 | 291,120 | 32,700 | 323,820 | 8 | 125 | 4 | 148 |
| Muskingum | 380 | 28,550 | 1,095 | 49,610 | 17,090 | 17,700 | 112,950 | 18,170 | 131,120 | 3 | 60 | 2 | 40 |
| Noble | 235 | 8,550 | 75 | 7,500 | 4,450 | 1,840 | 22,340 | 1,350 | 23,690 | 1 | 25 | 1 | 3 |
| Perry | 15,614 | 1,031,259 | 4,435 | 369,400 | 170,288 | 126,665 | 1,697,612 | 140,650 | 1,838,262 | 24 | 694 | 19 | 308 |
| Portage | | | 90 | 5,508 | 14,033 | 3,382 | 22,923 | 9,000 | 31,923 | 2 | 80 | 2 | 11 |
| Stark | 461 | 66,600 | 3,513 | 290,200 | 254,750 | 167,500 | 779,050 | 115,500 | 894,550 | 65 | 2,520 | 65 | 164 |
| Summit | | | 585 | 42,750 | 40,400 | 17,500 | 100,650 | 15,000 | 115,650 | 9 | 280 | 6 | 12 |
| Trumbull | 387 | 28,075 | 730 | 65,500 | 87,825 | 17,800 | 199,200 | 16,300 | 215,500 | 11 | 210 | 4 | 26 |
| Tuscarawas | 4,003 | 337,337 | 2,106 | 160,450 | 115,840 | 96,027 | 709,654 | 57,100 | 766,754 | 9 | 292 | 7 | 153 |
| Vinton | 4,690 | 152,550 | 510 | 22,750 | 77,975 | 40,250 | 293,525 | 9,350 | 302,875 | 1 | 30 | 8 | 29 |
| Washington | 100 | 2,000 | 300 | 12,000 | 4,000 | 2,200 | 20,200 | 1,200 | 21,400 | | | | 11 |
| Wayne | 500 | 25,000 | 4 | 700 | 20,500 | 26,500 | 72,700 | 13,200 | 85,900 | 4 | 100 | 4 | 21 |

Eleventh Census of the United States.

Robert P. Porter, Superintendent.



▨ Bituminous.

■ Anthracite.

## MAP OF PENNSYLVANIA.

Showing the Anthracite and Bituminous Coalfields.

## PENNSYLVANIA.

### ANTHRACITE COAL FIELDS.

The anthracite coal fields of Pennsylvania are situated in the eastern part of the state, and extend about equal distances north and south of a line drawn through the middle of the state from east to west, in the counties of Carbon, Columbia, Dauphin, Lackawanna, Luzerne, Northumberland, Schuylkill, Sullivan, and Susquehanna, and known under 3 general divisions, viz, Wyoming, Lehigh, and Schuylkill regions. Geologically they are divided into 5 well-defined fields or basins, which are again subdivided, for convenience of identification, into districts, as follows:

| FIELDS OR BASINS. | LOCAL DISTRICTS. | TRADE REGIONS. |
|---|---|---|
| Northern | Carbondale | Wyoming. |
| | Scranton | |
| | Pittston | |
| | Wilkesbarre | |
| | Plymouth | |
| | Kingston | |
| Western Northern | Bernice | |
| Eastern Middle | Green Mountain | Lehigh. |
| | Black Creek | |
| | Hazleton | |
| | Beaver Meadow | |
| Southern | Panther Creek | |
| | East Schuylkill | Schuylkill. |
| | West Schuylkill | |
| | Lorberry | |
| | Lykens Valley | |
| Western Middle | East Mahanoy | |
| | West Mahanoy | |
| | Shamokin | |

### BOUNDARIES OF MINE INSPECTORS' DISTRICTS, ANTHRACITE REGION, IN 1889.

FIRST DISTRICT.—That portion of the Wyoming coal field included in the counties of Lackawanna, Wayne, and Susquehanna.

SECOND DISTRICT.—The county of Sullivan and that portion of the Wyoming coal field situated in Luzerne county, east of and including Plains and Kingston townships.

THIRD DISTRICT.—The remaining portion of the Wyoming coal field, west of Plains and Kingston townships, including the city of Wilkesbarre and the boroughs of Kingston and Edwardsville.

FOURTH DISTRICT.—That part of Luzerne county lying south of the Wyoming coal field, together with Carbon county.

FIFTH DISTRICT.—That part of the Schuylkill coal field in Schuylkill county lying north of the Broad mountain and east of a meridian line through the center of the borough of Girardville.

SIXTH DISTRICT.—That part of the Schuylkill coal field in Schuylkill county lying north of the Broad mountain and west of a meridian line through the center of the borough of Girardville, together with Columbia, Northumberland, and Dauphin counties.

SEVENTH DISTRICT.—All that part of the Schuylkill coal field in Schuylkill county lying south of the Mahanoy valley, and the county of Lebanon.

### PRODUCTION OF ANTHRACITE COAL OF ALL GRADES IN 1889, BY COUNTIES.

[Long tons.]

| COUNTIES. | Total product of coal of all grades for year 1889. | DISPOSITION OF TOTAL PRODUCT. | | |
|---|---|---|---|---|
| | | Loaded at mines for shipment on railroad cars. | Used by employés and sold to local trade at mines. | Used for heat and steam at mines. |
| Total | 40, 665, 152 | 35, 816, 876 | 1, 329, 580 | 3, 518. 696 |
| Susquehanna and Sullivan | 351, 842 | 319, 126 | 5, 820 | 26, 896 |
| Lackawanna | 8, 939, 621 | 7, 823, 694 | 588, 535 | 527, 392 |
| Luzerne | 16, 607, 177 | 14, 892, 324 | 446, 036 | 1, 268, 817 |
| Carbon | 1, 210, 973 | 1, 080, 544 | 19, 592 | 110, 837 |
| Schuylkill | 9, 052, 619 | 7, 837, 369 | 181, 893 | 1, 033, 357 |
| Columbia | 628, 695 | 539, 273 | 15, 663 | 73, 759 |
| Northumberland | 3, 176, 740 | 2, 770, 914 | 57, 857 | 347. 969 |
| Dauphin | 697, 485 | 553, 632 | 14, 184 | 129, 669 |

The total production of anthracite coal in Pennsylvania during the calendar year 1889 was 40,665,152 tons of 2,240 pounds (equal to 45,544,970 tons of 2,000 pounds), valued at the mines at $65,721,578, or an average of $1.77 per long ton, including all sizes sent to market. In the 35,816,876 tons "loaded for shipment" is included unsalable sizes temporarily stocked at convenient points near the mines and tonnage loaded into cars but not passed over railroad scales, as well as waste in rehandling in the various processes of cleaning the smaller sizes. The quantity reported by the transportation companies as actually carried to market, which is the usual basis for statistics of shipments, was 35,407,710 tons during the year 1889. 1,329,580 tons were used by employés and sold to local trade in the vicinity of the mines, and 3,518,696 tons were reported as consumed for steam and heating purposes in and about the mines. The item of colliery consumption, however, is somewhat indefinite, the coal being taken either from the current mining or from screenings and used where needed, often without preparation, and rarely included in the accounts of the operator, being reported to the Census Office in most instances as "approximated". For these reasons it has been excluded from the basis of valuation of the product at the mines.

The average number of days worked during the year 1889 by all collieries was 194. The suspension of mining during periods aggregating about one-third of the year was caused mainly by the inability of the market to absorb a larger product. The number of persons employed during the year, including superintendents, engineers, and clerical force, was 124,203. The total amount paid in wages to all classes during the year was $39,278,355. The total number of regular establishments or breakers equipped for the preparation and shipment of coal was 362, of which 19 were idle during the year. Besides these there were 49 small diggings and washeries, supplying local trade. There were also 18 new establishments in course of construction.

The statistics of anthracite coal in Pennsylvania compiled for the Tenth Census were based upon the year ended June 30, 1880, and thus covered the last 6 months of 1879 and the first 6 months of 1880. The present census covers the calendar year 1889. The following items from the previous census are given to show the developments which a decade has made in this industry:

TENTH CENSUS STATISTICS OF ANTHRACITE COAL.

| | |
|---|---|
| Total production for census year, including all coal shipped to market and sold to employés and local trade about the mines, exclusive of culm (long tons) | 25,572,160 |
| Equal to (short tons) | 28,640,819 |
| Value of product at mines | $42,172,948 |
| Average price of all grades per long ton at mines | $1.65 |
| Total shipments for census year (long tons) | 24,566,822 |
| Total shipments for calendar year 1879 | 26,142,689 |
| Total shipments for calendar year 1880 | 23,437,242 |
| Total number of collieries | 275 |
| Total amount of wages paid in the Tenth Census year | $22,664,055 |
| Total number of employés, all grades | 70,669 |

The largest actual shipment during any year in the history of the trade was made in 1888, being 38,145,178 tons of 2,240 pounds. The largest actual shipment for any month was 4,187,527 tons, in October, 1888. The largest actual shipments ever made in each of the months of any year to December, 1889, inclusive, are given in the table below, and show that if the mines should be operated as actively every month of the year as they have been in that month the product for the year would be a little less than 40,000,000 long tons. The shipment of 1889 was therefore 90 per cent of the maximum shipments practicable under existing conditions.

LARGEST SHIPMENT FOR EACH MONTH OF ANY YEAR.

| YEARS. | Months. | Tonnage. |
|---|---|---|
| 1889 | January | 2,622,529 |
| 1887 | February | 2,551,003 |
| 1887 | March | 2,911,272 |
| 1888 | April | 2,856,593 |
| 1889 | May | 3,016,531 |
| 1889 | June | 3,038,216 |
| 1889 | July | 3,627,522 |
| 1888 | August | 4,097,563 |
| 1888 | September | 3,916,326 |
| 1888 | October | 4,187,527 |
| 1888 | November | 3,718,652 |
| 1887 | December | 3,068,079 |
| | Maximum shipment practicable | 39,611,813 |

| | |
|---|---|
| Average monthly tonnage based upon largest shipments ever made | 3,300,984 |
| Average annual shipments during 10 years ending with 1889 | 31,552,301 |
| Average annual shipments during 5 years ending with 1889 | 34,390,868 |

The following tables show the distribution of anthracite coal for 1889 and shipments since 1820:

## DISTRIBUTION OF ANTHRACITE COAL FOR 1889.

| SECTIONS. | Long tons. | Per cent. |
|---|---|---|
| Total | 35, 407, 710 | 100. 00 |
| Pennsylvania, New York, and New Jersey | 22, 314, 331 | 63. 02 |
| New England states | 5, 407, 357 | 15. 27 |
| Western states | 4, 922, 076 | 13. 90 |
| Southern states | 1, 613, 120 | 4. 56 |
| Pacific coast | 20, 900 | 0. 06 |
| Canada | 1, 094, 736 | 3. 09 |
| Foreign | 35, 190 | 0. 10 |

## SHIPMENTS OF ANTHRACITE COAL SINCE 1820.

| YEARS. | Total. | SCHUYLKILL REGION. | | LEHIGH REGION. | | WYOMING REGION. | |
|---|---|---|---|---|---|---|---|
| | | Long tons. | Per cent. | Long tons. | Per cent. | Long tons. | Per cent. |
| Total | 702, 166, 148 | 253, 484, 053 | 36. 10 | 128, 490, 084 | 18. 30 | 320, 192, 011 | 45. 60 |
| From 1820 to 1859, inclusive | 83, 835, 841 | 44, 049, 622 | 52. 54 | 17, 755, 009 | 21. 18 | 22, 031, 210 | 26. 28 |
| From 1860 to 1869, inclusive | 107, 092, 918 | 44, 769, 022 | 41. 80 | 20, 035, 073 | 18. 71 | 42, 288, 823 | 39. 49 |
| From 1870 to 1879, inclusive | 195, 714, 376 | 68, 237, 040 | 34. 87 | 35, 683, 152 | 18. 23 | 91, 794, 184 | 46. 90 |
| From 1880 to 1889, inclusive | 315, 523, 013 | 96, 428, 369 | 30. 56 | 55, 016, 850 | 17. 44 | 164, 077, 794 | 52. 00 |

The initial lines of transportation from the anthracite coal fields are operated by the following companies:

Delaware, Lackawanna and Western Railroad Company.
New York, Susquehanna and Western Railroad Company.
New York, Ontario and Western Railroad Company. (*a*)
Delaware and Hudson Canal Company.
Erie and Wyoming Valley Railroad Company.
Central Railroad Company of New Jersey.
Lehigh Valley Railroad Company.
Pennsylvania Railroad Company.
Philadelphia and Reading Railroad Company.
New York, Lake Erie and Western Railroad Company.

*a* In course of construction.

## ANTHRACITE COAL PRODUCT OF PENNSYLVANIA IN 1889, BY COUNTIES.

[Long tons.]

| COUNTIES. | Total product of coal of all grades for year 1889. | DISPOSITION OF TOTAL PRODUCT. | | | | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|
| | | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | | |
| Total (long tons) | 40, 665, 152 | 35, 816, 876 | 1, 038, 874 | 290, 706 | 3, 518, 696 | *a* $65, 721, 578 | *a* $1. 77 |
| Total (short tons) | 45, 544, 970 | 40, 114, 901 | 1, 163, 539 | 325, 591 | 3, 940, 939 | .............. | *a* 1. 58 |
| Lackawanna | 8, 939, 621 | 7, 823, 694 | 564, 349 | 24, 186 | 527, 392 | 14, 310, 367 | 1, 60 |
| Luzerne | 16, 607, 177 | 14, 892, 324 | 312, 977 | 133, 059 | 1, 268, 817 | 27, 160, 478 | 1. 64 |
| Susquehanna and Sullivan | 351, 842 | 319, 126 | 3, 712 | 2, 108 | 26, 896 | 557, 592 | 1. 58 |
| Carbon | 1, 210, 973 | 1, 080, 544 | 13, 861 | 5, 731 | 110, 837 | 2, 024, 228 | 1. 67 |
| Schuylkill | 9, 052, 619 | 7, 837, 369 | 101, 745 | 80, 148 | 1, 033, 357 | 14, 461, 754 | 1. 60 |
| Northumberland | 3, 176, 740 | 2, 770, 914 | 31, 353 | 26, 504 | 347, 969 | 4, 896, 032 | 1. 54 |
| Columbia | 628, 695 | 539, 273 | 7, 255 | 8, 408 | 73, 759 | 1, 052, 334 | 1. 67 |
| Dauphin | 697, 485 | 553, 632 | 3, 622 | 10, 562 | 129, 669 | 1, 258, 793 | 1. 80 |

*a* Not including value of anthracite used for steam at the mines.

## LABOR AND WAGES AT PENNSYLVANIA ANTHRACITE COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mine. | ABOVE GROUND. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total average number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Total | 123, 676 | 46, 154 | 564 | $2. 71 | 291 | 4, 720 | $1. 91 | 257 | 23, 779 | $1. 29 | 198 | 17, 091 | $0. 62 | 185 |
| Susquehanna and Sullivan. | 880 | 371 | 5 | 2. 50 | 306 | 43 | 1. 94 | 246 | 244 | 1. 33 | 220 | 79 | 0. 58 | 212 |
| Lackawanna | 25, 290 | 7, 299 | 92 | 2. 86 | 288 | 855 | 1. 98 | 267 | 2, 722 | 1. 36 | 189 | 3, 630 | 0. 63 | 165 |
| Luzerne | 46, 071 | 17, 934 | 261 | 2. 70 | 292 | 1, 527 | 1. 99 | 273 | 10, 880 | 1. 30 | 192 | 5, 266 | 0. 54 | 177 |
| Carbon | 3, 189 | 1, 743 | 20 | 2. 72 | 274 | 171 | 1. 65 | 279 | 1, 241 | 1. 11 | 251 | 311 | 0. 53 | 240 |
| Schuylkill | 30, 760 | 12, 489 | 133 | 2. 63 | 282 | 1, 500 | 1. 82 | 219 | 5, 984 | 1. 29 | 200 | 4, 872 | 0. 67 | 199 |
| Columbia | 2, 341 | 928 | 10 | 3. 25 | 314 | 124 | 1. 90 | 283 | 341 | 1. 31 | 224 | 453 | 0. 74 | 196 |
| Northumberland | 12, 835 | 4, 657 | 38 | 2. 65 | 314 | 423 | 1. 80 | 287 | 2, 041 | 1. 28 | 187 | 2, 155 | 0. 66 | 182 |
| Dauphin | 2, 310 | 733 | 5 | 2. 42 | 313 | 77 | 2. 00 | 319 | 326 | 1. 31 | 264 | 325 | 0. 69 | 264 |

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total average number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Total | 77, 522 | 737 | $3. 05 | 291 | 36, 639 | $2. 39 | 179 | 35, 376 | $1. 64 | 184 | 4, 770 | $0. 88 | 180 | $38, 867, 331 |
| Susquehanna and Sullivan. | 509 | 4 | 2. 96 | 310 | 327 | 3. 16 | 205 | 163 | 1. 56 | 225 | 15 | 0. 63 | 232 | 401, 892 |
| Lackawanna | 17, 991 | 104 | 3. 31 | 282 | 7, 265 | 2. 63 | 162 | 8, 593 | 1. 75 | 171 | 2, 029 | 0. 93 | 165 | 8, 290, 287 |
| Luzerne | 28, 137 | 271 | 3. 21 | 292 | 11, 726 | 2. 70 | 182 | 14, 493 | 1. 64 | 183 | 1, 647 | 0. 86 | 182 | 15, 289, 670 |
| Carbon | 1, 446 | 14 | 3. 24 | 278 | 593 | 2. 27 | 251 | 756 | 1. 65 | 252 | 83 | 0. 89 | 248 | 1, 260, 902 |
| Schuylkill | 18, 271 | 235 | 2. 83 | 294 | 10, 375 | 2. 10 | 176 | 7, 090 | 1. 51 | 181 | 571 | 0. 82 | 197 | 8, 527, 129 |
| Columbia | 1, 413 | 11 | 2. 85 | 275 | 642 | 2. 06 | 202 | 714 | 1. 66 | 192 | 46 | 0. 84 | 191 | 706, 725 |
| Northumberland | 8, 178 | 88 | 2. 84 | 292 | 5, 099 | 2. 01 | 182 | 2, 737 | 1. 56 | 188 | 254 | 0. 82 | 181 | 3, 480, 979 |
| Dauphin | 1, 577 | 10 | 2. 83 | 307 | 612 | 2. 24 | 262 | 830 | 1. 58 | 265 | 125 | 0. 96 | 265 | 909, 747 |

## EXPENDITURES AT PENNSYLVANIA ANTHRACITE COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| Total | 527 | $411, 024 | 526 | $410, 774 | 1 | $250 | 124, 203 | $39, 278, 355 | $10, 822, 363 | $8, 676, 320 | $58, 777, 038 | $2, 332, 929 | $61, 109, 958 |
| Susquehanna and Sullivan. | 4 | 2, 674 | 4 | 2, 674 | ...... | ............ | 884 | 404, 566 | 38, 632 | 76, 547 | 519, 745 | ............ | 519, 745 |
| Lackawanna | 98 | 73, 527 | 97 | 73, 277 | 1 | 250 | 25, 388 | 8, 363, 814 | 1, 776, 016 | 1, 162, 307 | 11, 302, 137 | 330, 759 | 11, 632, 896 |
| Luzerne | 210 | 183, 992 | 210 | 183, 992 | ...... | ............ | 46, 281 | 15, 473, 662 | 4, 242, 236 | 3, 664, 812 | 23, 380, 710 | 498, 199 | 23, 878, 909 |
| Carbon | 17 | 17, 266 | 17 | 17, 266 | ...... | ............ | 3, 206 | 1, 278, 168 | 325, 768 | 83, 895 | 1, 687, 831 | 96, 293 | 1, 784, 124 |
| Schuylkill | 132 | 86, 038 | 132 | 86, 038 | ...... | ............ | 30, 892 | 8, 613, 167 | 3, 036, 485 | 2, 527, 629 | 14, 177, 281 | 1, 038, 345 | 15, 215, 626 |
| Columbia | 10 | 5, 753 | 10 | 5, 753 | ...... | ............ | 2, 351 | 712, 478 | 210, 282 | 221, 027 | 1, 143, 787 | 63, 737 | 1, 207, 524 |
| Northumberland | 44 | 32, 049 | 44 | 32, 049 | ...... | ............ | 12, 879 | 3, 513, 028 | 987, 792 | 914, 262 | 5, 415, 082 | 289, 392 | 5, 704, 474 |
| Dauphin | 12 | 9, 725 | 12 | 9, 725 | ...... | ............ | 2, 322 | 919, 472 | 205, 152 | 25, 841 | 1, 150, 465 | 16, 195 | 1, 166, 660 |

## VALUE OF AND POWER AT PENNSYLVANIA ANTHRACITE COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | | | POWER USED IN MINING. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | Steam boilers. | | Number of cylinders. | Other power. | | |
| | | | | | | | | | | | | | Motors. | | Number of animals employed. |
| | Acres. | Value. | Acres. | Value. | | | | | | Number. | Horse power. | | Number. | Horse power. | |
| Total | 107, 282 | $47, 626, 322 | 106, 656 | $56, 789, 480 | $36,733,648 | $14,110,617 | $155,260,067 | $6, 524, 406 | $161,784,473 | 6, 634 | 154, 077 | 3, 570 | 153 | 6, 906 | 12, 463 |
| Susquehanna and Sullivan. | 5, 648 | 824, 000 | 717 | 800, 000 | 182, 693 | 297, 825 | 2, 104, 518 | 80, 850 | 2, 185, 368 | 25 | 1, 080 | 20 | 3 | 52 | 110 |
| Lackawanna | 14, 962 | 8, 279, 920 | 17, 900 | 11, 680, 895 | 7, 635, 719 | 2, 194, 108 | 29, 790, 642 | 1, 427, 131 | 31, 217, 773 | 977 | 31, 835 | 711 | 20 | 769 | 3, 150 |
| Luzerne | 37, 935 | 13, 748, 296 | 64, 935 | 32, 616, 327 | 15, 843, 814 | 5, 957, 697 | 68, 166, 134 | 2, 921, 433 | 71, 087, 567 | 2, 855 | 62, 847 | 1, 520 | 98 | 5, 163 | 5, 099 |
| Carbon | 4, 253 | 2, 531, 977 | 800 | 450, 000 | 1, 624, 414 | 808, 870 | 5, 415, 261 | 182, 310 | 5, 597, 571 | 303 | 5, 983 | 112 | 5 | 152 | 394 |
| Schuylkill | 32, 401 | 20, 733, 469 | 9, 181 | 6, 079, 100 | 9, 051, 060 | 3, 723, 883 | 39, 587, 512 | 1, 441, 425 | 41, 028, 937 | 1, 922 | 37, 531 | 911 | 20 | 540 | 2, 745 |
| Columbia | 230 | 23, 000 | 3, 393 | 1, 115, 000 | 725, 313 | 270, 447 | 2, 133, 760 | 72, 782 | 2, 206, 542 | 115 | 2, 548 | 85 | 1 | 30 | 149 |
| Northumberland | 250 | 325, 360 | 9, 730 | 4, 048, 158 | 1, 515, 635 | 622, 787 | 6, 511, 940 | 302, 475 | 6, 814, 415 | 271 | 7, 605 | 133 | 2 | 40 | 560 |
| Dauphin | 11, 603 | 1, 160, 300 | ........ | ............ | 155, 000 | 235, 000 | 1, 550, 300 | 96, 000 | 1, 646, 300 | 166 | 4, 648 | 78 | 4 | 160 | 256 |

### BITUMINOUS COAL FIELDS.

The bituminous coal deposits of Pennsylvania form the northern extremity of the great Appalachian coal fields, and to a greater or less extent underlie all the territory of the state lying west of the crest of the Allegheny mountains. The counties of Bradford, Tioga, Potter, Warren, Crawford, Venango, Forest, Elk, Cameron, Clinton, and Lycoming, in the northern portion of the state, exhibit only detached basins of the lower measures, which, however, are extensively mined, and the product finds ready markets for manufacturing purposes and for steam. The remaining counties, bounded by the western and southern state lines and a line drawn northward along the eastern boundaries of Fulton, Huntingdon, and Centre counties, thence westwardly along the northern boundaries of Clearfield, Jefferson, Clarion, and Mercer, embrace an almost unbroken area of one or more of the important beds belonging to the carboniferous measures. The counties of Allegheny, Westmoreland, Washington, Greene, and Fayette, situated in the southwestern corner of the state, contain the upper productive measures, at the bottom of which lies the notable Pittsburg bed, yielding in the vicinity of Pittsburg a gas coal of the highest quality; to the eastward the coking coals from which the celebrated Connellsville coke is made, and to the southward the Cumberland steam coals of Maryland. Small areas of this bed also occur in Indiana, Somerset, and Beaver counties. The remaining counties referred to contain only the lower productive measures, ranging from the isolated areas of the Pittsburg bed to the Brookville bed, the lowest in the lower productive series, and the Mercer, Quakertown, and Sharon beds in the conglomerate series. The product from this territory, as well as that from the southwestern counties, wherever the lower measures are being mined, is classed in the trade as semibituminous, containing, as it does, less than 18 per cent of volatile combustible matter. While an excellent quality of coke is produced from coals mined in some localities from these lower measures, the distinctive advantages consist in their superiority as steam and rolling mill fuels, being much sought after for locomotive and steamship uses. In the Freeport and Kittanning beds of the lower productive series cannel coal of good quality has been found to overlie the seam for considerable areas in certain localities, but on account of the veins being thin and troublesome to separate in mining it is not deemed of much commercial value.

The quantity of coal mined by the small local banks and farmers' diggings in the state, as reported to the Census Office, was 820,197 short tons. This product has not heretofore appeared in any of the compilations of the output of the bituminous districts. As the collection of this data was delegated to resident special agents in each county, who were familiar with the territory under their charge, it is believed that the information is complete, and that it presents reliable statistics relating to this important element of the mining industry in Pennsylvania. The quantity sold to the local trade by the regular establishments, and that consumed by the employés, together with this neighborhood mining, reached an aggregate of 1,590,651 short tons, or 4.40 per cent of the entire production. The total quantity of coal manufactured into coke during the year 1889, as reported to the Census Office, was 10,190,588 short tons, or 28.17 per cent of the total production. As will be seen by the accompanying table, the larger portion of this amount was produced in Westmoreland and Fayette counties, embracing the well-known Connellsville region. Coke of excellent quality is also obtained from the coals of the Mountain, Clearfield, Punxsutawney, and Reynoldsville districts, and its manufacture is increasing in importance in those localities.

The output of bituminous coal in the state of Pennsylvania during the year ended June 30, 1880, as reported to the Tenth Census, was 18,425,163 tons of 2,000 pounds, valued at $18,567,129, or an average of 100.8 cents per ton. The average number of persons of all classes employed was 33,248, and the total amount of wages paid $10,863,583.

During the calendar year 1889 there were in operation 525 regular establishments and 2,949 country banks, producing a total of 36,174,089 short tons, nearly double the output of the census year 1880. The average number of persons of all classes employed was 53,712, and the amount paid in wages $20,738,647. The value of the total product at the mines, including that consumed in mining operations during the year, was $27,953,315, or an average of $0.77 per short ton. No attempt has been made to determine the number of persons employed and the basis of wages at the country banks, owing to the irregular character of the operations.

The following is a list of the mine inspectors' districts, the local districts, and the counties constituting the bituminous coal fields of Pennsylvania:

### MINE INSPECTORS' AND LOCAL DISTRICTS, BITUMINOUS REGION.

BOUNDARIES OF MINE INSPECTORS' DISTRICTS IN 1889.

| FIRST DISTRICT. | SECOND DISTRICT. | THIRD DISTRICT. | FOURTH DISTRICT. |
|---|---|---|---|
| Greene county, Washington county, Westmoreland county west of Youghiogheny river, Fayette county along Monongahela river | Allegheny county east of the Allegheny, Monongahela, and Youghiogheny rivers, Westmoreland county except along West Pennsylvania railroad, and Pennsylvania railroad west of Brinton. | Beaver county, Lawrence county, Butler county, Armstrong county, Westmoreland county along West Pennsylvania railroad, Mercer county, Venango county, Clarion county. | Bradford county, Tioga county, Lycoming county, Clinton county, McKean county, Elk county, Jefferson county, Clearfield county along Allegheny Valley railroad. |

LOCAL DISTRICTS.

| | | | |
|---|---|---|---|
| Greene county.<br>Washington county:<br>Monongahela river, 3d pool, west.<br>Monongahela river, 4th pool, west.<br>Pittsburg.<br>Pan Handle.<br>Westmoreland county:<br>Monongahela river, 3d pool, east.<br>Youghiogheny river, west<br>Connellsville, north.<br>Westmoreland.<br>Kiskiminitas river, south.<br>Fayette county:<br>Monongahela river, 4th pool, east. | Westmoreland county:<br>Monongahela river, 3d pool, east.<br>Youghiogheny river, west.<br>Connellsville, north.<br>Allegheny county:<br>Allegheny river, east.<br>Monongahela river, 1st pool, south.<br>Monongahela river, 2d pool, east.<br>Monongahela river, 3d pool, east.<br>Youghiogheny river, east. | Beaver county:<br>Beaver.<br>Lawrence county:<br>Lawrence.<br>Venango county.<br>Westmoreland county:<br>Kiskiminitas river, south.<br>Armstrong county:<br>Allegheny river, east.<br>Kiskiminitas river, north.<br>Reynoldsville.<br>Mercer county:<br>Mercer.<br>Clarion county:<br>Reynoldsville.<br>Lucinda Furnace.<br>Allegheny river, east.<br>Butler county:<br>Butler. | Clearfield county:<br>Reynoldsville.<br>Caledonia.<br>Bradford county:<br>Barclay.<br>Lycoming county.<br>Tioga county:<br>Blossburg.<br>Gurnee.<br>Antrim.<br>Clinton county:<br>Kettle Creek.<br>Farrandsville.<br>McKean county.<br>Cameron county.<br>Elk county:<br>Caledonia.<br>Dagus.<br>Philadelphia and Erie railroad.<br>Jefferson county:<br>Dagus.<br>Punxsutawney.<br>Reynoldsville. |

BOUNDARIES OF MINE INSPECTORS' DISTRICTS IN 1889.

| FIFTH DISTRICT. | SIXTH DISTRICT. | SEVENTH DISTRICT. | EIGHTH DISTRICT. |
|---|---|---|---|
| Somerset county, Fayette county except along the Monongahela river. | Blair county, Cambria county, Indiana county, Clearfield county along Bells Gap railroad to Irvona, Westmoreland county along Pennsylvania railroad east of Brinton. | Allegheny county west of the Allegheny, Monongahela, and Youghiogheny rivers. | Huntingdon county, Bedford county, Centre county, Clearfield county except along Bells Gap railroad to Irvona, and along the Allegheny Valley railroad. |

LOCAL DISTRICTS.

| | | | |
|---|---|---|---|
| Fayette county:<br>Connellsville, south.<br>Youghiogheny river, east and west banks.<br>Somerset county:<br>Myersdale. | Clearfield county:<br>Bells Gap, Clearfield.<br>Westmoreland county:<br>Westmoreland.<br>Blair county:<br>Mountain.<br>Cambria county:<br>Hastings.<br>Bells Gap, Clearfield.<br>Indiana county:<br>Kiskiminitas river, north.<br>Black Lick.<br>Cush Creek. | Allegheny county:<br>Allegheny river, west.<br>Peters Creek.<br>Montour run.<br>Pittsburg.<br>Pan Handle. | Clearfield county:<br>Tyrone and Clearfield railroad.<br>Beech Creek railroad.<br>Centre county:<br>Snow Shoe.<br>Huntingdon county:<br>Broad Top.<br>Bedford county:<br>Broad Top. |

The following table shows the total product of bituminous coal in Pennsylvania in 1889 and the disposition of the same:

BITUMINOUS COAL PRODUCT OF PENNSYLVANIA IN 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | Total product of coal of all grades for year 1889. | DISPOSITION OF TOTAL PRODUCT. | | | | | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|
| | | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | Manufactured into coke. | | |
| Total | 36, 174, 089 | 24, 059, 913 | 1, 432, 361 | 158, 290 | 332, 937 | 10, 190, 588 | $27, 953, 315 | $0. 77 |
| Allegheny | 4, 717, 431 | 4, 464, 376 | 193, 216 | 11, 066 | 25, 103 | 23, 670 | 4, 000, 104 | 0. 85 |
| Armstrong | 289, 218 | 229, 402 | 54, 879 | 4, 581 | 356 | ............... | 210, 067 | 0. 73 |
| Beaver | 93, 461 | 44, 932 | 48, 006 | 174 | 249 | 100 | 110, 604 | 1. 18 |
| Bedford | 257, 453 | 237, 554 | 4, 743 | 2, 189 | 3, 889 | 9, 078 | 205, 672 | 0. 80 |
| Blair | 215, 410 | 80, 777 | 1, 716 | 2, 472 | 2, 918 | 127, 527 | 210, 466 | 0. 98 |
| Bradford | 129, 141 | 121, 976 | 4, 772 | 1, 593 | 800 | ............... | 171, 387 | 1. 33 |
| Butler | 288, 591 | 183, 477 | 91, 202 | 2, 862 | 2, 162 | 8, 888 | 270, 394 | 0. 94 |
| Cambria | 1, 751, 664 | 1, 174, 508 | 169, 548 | 9, 977 | 7, 296 | 390, 335 | 1, 348, 484 | 0. 77 |
| Cameron | 2, 300 | 1, 400 | 90 | 420 | 104 | 286 | 1, 650 | 0. 72 |
| Centre | 395, 127 | 380, 331 | 3, 976 | 988 | 115 | 9, 717 | 311, 544 | 0. 79 |
| Clarion | 596, 589 | 535, 251 | 53, 517 | 3, 983 | 3, 370 | 468 | 430, 850 | 0. 72 |
| Clinton | 107, 636 | 99, 074 | 8, 092 | 240 | 230 | ............... | 81, 373 | 0. 76 |
| Clearfield | 5, 224, 506 | 4, 937, 506 | 75, 954 | 13, 626 | 19, 651 | 177, 769 | 4, 403, 551 | 0. 84 |
| Elk | 614, 113 | 596, 014 | 7, 226 | 323 | 4, 789 | 5, 761 | 498, 728 | 0. 81 |
| Fayette | 5, 897, 254 | 593, 149 | 79, 127 | 32, 587 | 101, 272 | 5, 091, 119 | 3, 702, 548 | 0. 63 |
| Greene | 53, 714 | ............... | 52, 383 | 1, 331 | ............... | ............... | 57, 307 | 1. 07 |
| Huntingdon | 280, 133 | 185, 799 | 3, 938 | 5, 173 | 3, 129 | 82, 094 | 211, 597 | 0. 76 |
| Indiana | 153, 698 | 53, 498 | 79, 653 | 547 | ............... | 20, 000 | 124, 088 | 0. 81 |
| Jefferson | 2, 896, 487 | 2, 371, 703 | 44, 985 | 8, 699 | 11, 403 | 459, 697 | 2, 117, 531 | 0. 73 |
| Lawrence | 143, 410 | 117, 094 | 25, 270 | 426 | 620 | ............... | 150, 537 | 1. 05 |
| Lycoming | 360 | ............... | 360 | ............... | ............... | ............... | 420 | 1. 17 |
| McKean | 11, 390 | 11, 107 | 283 | ............... | ............... | ............... | 12, 237 | 1. 07 |
| Mercer | 575, 751 | 509, 737 | 46, 550 | 4, 681 | 14, 783 | ............... | 511, 202 | 0. 89 |
| Somerset | 442, 027 | 370, 791 | 48, 650 | 2, 259 | 586 | 19, 741 | 308, 400 | 0. 70 |
| Tioga | 1, 036, 175 | 1, 010, 544 | 6, 420 | 6, 152 | 8, 543 | 4, 516 | 1, 264, 889 | 1. 22 |
| Venango | 5, 025 | ............... | 4, 809 | 216 | ............... | ............... | 5, 706 | 1. 14 |
| Washington | 2, 364, 901 | 2, 261, 040 | 57, 874 | 6, 973 | 11, 972 | 27, 042 | 1, 557, 486 | 0. 66 |
| Westmoreland | 7, 631, 124 | 3, 488, 873 | 265, 122 | 34, 752 | 109, 597 | 3, 732, 780 | 5, 674, 493 | 0. 74 |

## LABOR AND WAGES AT PENNSYLVANIA BITUMINOUS COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mine. | ABOVE GROUND. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total average number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Total | 53, 132 | 4, 979 | 378 | $2. 57 | 250 | 1, 028 | $2. 13 | 237 | 3, 366 | $1. 67 | 208 | 207 | $0. 83 | 200 |
| Allegheny | 9, 314 | 910 | 68 | 2. 83 | 296 | 145 | 2. 26 | 210 | 661 | 1. 94 | 183 | 36 | 1. 05 | 157 |
| Armstrong | 454 | 43 | 5 | 2. 39 | 165 | 8 | 1. 82 | 234 | 30 | 1. 45 | 196 | ........ | ........ | ........ |
| Beaver | 158 | 18 | 2 | 2. 00 | 297 | 2 | 2. 08 | 290 | 14 | 1. 49 | 203 | ........ | ........ | ........ |
| Bedford | 554 | 48 | 9 | 2. 33 | 168 | 13 | 1. 85 | 175 | 26 | 1. 66 | 175 | ........ | ........ | ........ |
| Blair | 457 | 39 | 5 | 2. 72 | 147 | 10 | 2. 03 | 158 | 20 | 1. 54 | 198 | 4 | 0. 70 | 216 |
| Bradford | 317 | 55 | ........ | ........ | ........ | 7 | 2. 11 | 227 | 45 | 1. 44 | 216 | 3 | 0. 81 | 197 |
| Butler | 444 | 56 | 3 | 2. 67 | 209 | 17 | 1. 77 | 200 | 33 | 1. 44 | 199 | 3 | 0. 75 | 242 |
| Cambria | 2, 760 | 195 | 26 | 2. 58 | 251 | 44 | 2. 06 | 212 | 120 | 1. 65 | 206 | 5 | 0. 79 | 208 |
| Centre | 742 | 57 | 9 | 2. 25 | 187 | 12 | 1. 99 | 171 | 35 | 1. 63 | 182 | 1 | 0. 65 | 200 |
| Clarion | 927 | 119 | 9 | 2. 27 | 252 | 21 | 1. 85 | 218 | 84 | 1. 44 | 216 | 5 | 0. 75 | 149 |
| Clinton | 169 | 19 | 1 | 2. 50 | 235 | 5 | 2. 50 | 235 | 13 | 1. 96 | 238 | ........ | ........ | ........ |
| Elk | 1, 165 | 165 | 5 | 2. 56 | 202 | 16 | 2. 09 | 244 | 135 | 1. 34 | 218 | 9 | 0. 87 | 284 |
| Fayette | 6, 485 | 633 | 42 | 2. 62 | 252 | 189 | 2. 22 | 237 | 386 | 1. 75 | 219 | 16 | 0. 67 | 201 |
| Huntingdon | 537 | 58 | 5 | 2. 10 | 214 | 13 | 1. 82 | 222 | 39 | 1. 45 | 220 | 1 | 0. 75 | 210 |
| Indiana | 135 | 21 | 4 | 1. 75 | 160 | 1 | 2. 25 | 40 | 15 | 1. 43 | 123 | 1 | 0. 75 | 40 |
| Jefferson | 3, 691 | 343 | 13 | 2. 61 | 250 | 57 | 2. 18 | 243 | 262 | 1. 50 | 214 | 11 | 0. 70 | 255 |
| Lawrence | 260 | 37 | 9 | 1. 83 | 249 | 2 | 1. 88 | 276 | 24 | 1. 46 | 193 | 2 | 0. 75 | 252 |
| Mercer | 1, 078 | 150 | 13 | 1. 99 | 286 | 48 | 1. 86 | 248 | 82 | 1. 33 | 173 | 7 | 0. 85 | 157 |
| Somerset | 519 | 43 | 11 | 2. 08 | 254 | 10 | 1. 85 | 218 | 21 | 1. 48 | 242 | 1 | 0. 75 | 140 |
| Tioga | 2, 381 | 325 | 8 | 2. 31 | 264 | 38 | 1. 88 | 248 | 233 | 1. 43 | 205 | 46 | 0. 83 | 198 |
| Washington | 3, 933 | 294 | 29 | 3. 02 | 254 | 50 | 2. 51 | 236 | 194 | 1. 66 | 197 | 21 | 0. 79 | 187 |
| Westmoreland | 8, 962 | 880 | 61 | 2. 64 | 257 | 205 | 2. 13 | 276 | 588 | 1. 71 | 238 | 26 | 0. 84 | 239 |
| Other counties (*a*) | 52 | 18 | 1 | 2. 00 | 23 | ........ | ........ | ........ | 17 | 1. 38 | 59 | ........ | ........ | ........ |
| Clearfield | 7, 638 | 453 | 40 | 2. 43 | 225 | 115 | 2. 09 | 231 | 289 | 1. 73 | 211 | 9 | 0. 83 | 207 |

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total average number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Total | 48, 153 | 606 | $2. 57 | 256 | 40, 100 | $1. 93 | 210 | 5, 303 | $1. 84 | 220 | 2, 144 | $0. 78 | 217 | $20, 327, 805 |
| Allegheny | 8, 404 | 88 | 2. 61 | 270 | 7, 490 | 2. 04 | 165 | 594 | 2. 03 | 180 | 232 | 0. 83 | 196 | 3, 126, 352 |
| Armstrong | 411 | 5 | 2. 41 | 201 | 356 | 1. 57 | 194 | 41 | 1. 64 | 208 | 9 | 0. 54 | 225 | 142, 071 |
| Beaver | 140 | 5 | 2. 35 | 213 | 112 | 1. 81 | 174 | 9 | 1. 62 | 171 | 14 | 0. 98 | 138 | 47, 836 |
| Bedford | 506 | 7 | 2. 36 | 157 | 429 | 1. 69 | 173 | 55 | 1. 72 | 182 | 15 | 0. 58 | 164 | 162, 388 |
| Blair | 418 | 6 | 2. 33 | 238 | 327 | 1. 63 | 181 | 65 | 1. 73 | 198 | 20 | 1. 02 | 152 | 130, 796 |
| Bradford | 262 | 2 | 3. 42 | 270 | 196 | 2. 41 | 217 | 41 | 1. 59 | 218 | 23 | 0. 79 | 208 | 149, 222 |
| Butler | 388 | 14 | 2. 45 | 276 | 309 | 1. 70 | 197 | 50 | 1. 60 | 183 | 15 | 0. 75 | 173 | 143, 304 |
| Cambria | 2, 565 | 32 | 2. 42 | 251 | 2, 147 | 1. 87 | 222 | 250 | 1. 77 | 211 | 136 | 0. 70 | 202 | 1, 013, 613 |
| Centre | 685 | 9 | 2. 33 | 215 | 598 | 1. 83 | 168 | 53 | 1. 76 | 172 | 25 | 0. 72 | 182 | 225, 509 |
| Clarion | 808 | 14 | 2. 43 | 265 | 699 | 1. 80 | 191 | 70 | 1. 59 | 205 | 25 | 0. 64 | 200 | 323, 462 |
| Clinton | 150 | 2 | 2. 75 | 189 | 136 | 1. 96 | 236 | 10 | 2. 00 | 235 | 2 | 0. 75 | 235 | 78, 603 |
| Elk | 1, 000 | 15 | 2. 69 | 222 | 850 | 1. 90 | 195 | 72 | 1. 53 | 213 | 63 | 0. 66 | 252 | 421, 566 |
| Fayette | 5, 852 | 92 | 2. 76 | 260 | 4, 453 | 1. 87 | 235 | 1, 111 | 1. 95 | 244 | 196 | 0. 80 | 242 | 2, 571, 430 |
| Huntingdon | 479 | 4 | 2. 38 | 209 | 393 | 1. 78 | 203 | 59 | 1. 81 | 217 | 23 | 0. 66 | 167 | 194, 426 |
| Indiana | 114 | 5 | 1. 82 | 234 | 105 | 1. 81 | 120 | 4 | 1. 75 | 219 | ........ | ........ | ........ | 31, 427 |
| Jefferson | 3, 548 | 23 | 2. 54 | 260 | 2, 899 | 1. 95 | 233 | 506 | 1. 83 | 212 | 120 | 0. 78 | 221 | 1, 552, 253 |
| Lawrence | 223 | 4 | 2. 61 | 241 | 175 | 1. 74 | 224 | 24 | 1. 57 | 220 | 20 | 0. 88 | 237 | 93, 736 |
| Mercer | 928 | 14 | 2. 72 | 272 | 735 | 1. 70 | 208 | 122 | 1. 66 | 225 | 57 | 0. 71 | 218 | 370, 599 |
| Somerset | 476 | 13 | 2. 32 | 220 | 406 | 1. 81 | 218 | 45 | 1. 64 | 225 | 12 | 0. 73 | 245 | 198, 281 |
| Tioga | 2, 056 | 12 | 2. 84 | 278 | 1, 517 | 2. 42 | 194 | 314 | 1. 58 | 199 | 213 | 0. 73 | 198 | 975, 118 |
| Washington | 3, 639 | 45 | 2. 05 | 206 | 3, 227 | 1. 88 | 201 | 294 | 1. 78 | 186 | 73 | 0. 73 | 188 | 1, 365, 576 |
| Westmoreland | 8, 082 | 113 | 2. 66 | 283 | 6, 583 | 1. 89 | 248 | 1, 003 | 1. 88 | 248 | 383 | 0. 77 | 245 | 3, 937, 211 |
| Other counties (*a*) | 34 | 2 | 2. 00 | 132 | 26 | 1. 75 | 190 | 6 | 1. 43 | 168 | ........ | ........ | ........ | 12, 368 |
| Clearfield | 7, 185 | 80 | 2. 55 | 260 | 5, 932 | 1. 95 | 218 | 705 | 1. 81 | 223 | 468 | 0. 84 | 219 | 3, 060, 658 |

*a* Cameron and McKean counties.

## EXPENDITURES AT PENNSYLVANIA BITUMINOUS COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| Total | 580 | $410,842 | 566 | $404,312 | 14 | $6,530 | 53,712 | $20,738,647 | $2,393,386 | $2,562,851 | $25,694,884 | $282,222 | $25,977,106 |
| Allegheny | 72 | 55,598 | 71 | 55,198 | 1 | 400 | 9,386 | 3,181,950 | 328,774 | 224,031 | 3,734,755 | 4,684 | 3,739,439 |
| Armstrong | 5 | 3,300 | 5 | 3,300 | | | 459 | 145,371 | 10,596 | 4,279 | 160,246 | 4,608 | 164,854 |
| Beaver | 4 | 3,520 | 4 | 3,520 | | | 162 | 51,356 | 5,160 | 3,146 | 59,662 | 5,226 | 64,888 |
| Bedford | 6 | 1,953 | 6 | 1,953 | | | 560 | 164,341 | 13,760 | 28,447 | 206,548 | | 206,548 |
| Blair and Bradford | 13 | 8,661 | 13 | 8,661 | | | 787 | 288,679 | 39,493 | 19,962 | 348,134 | | 348,134 |
| Butler | 9 | 4,370 | 9 | 4,370 | | | 453 | 147,674 | 12,542 | 14,583 | 174,799 | | 174,799 |
| Cambria and Cameron. | 29 | 17,069 | 29 | 17,069 | | | 2,813 | 1,031,463 | 114,941 | 124,358 | 1,270,762 | 20,730 | 1,291,492 |
| Centre | 8 | 5,452 | 8 | 5,452 | | | 750 | 230,961 | 23,633 | 37,163 | 291,757 | | 291,757 |
| Clarion and Clinton. | 16 | 10,152 | 14 | 9,172 | 2 | 980 | 1,112 | 412,217 | 35,563 | 27,261 | 475,041 | 655 | 475,696 |
| Clearfield | 77 | 52,552 | 75 | 51,352 | 2 | 1,200 | 7,715 | 3,113,210 | 246,085 | 505,752 | 3,865,047 | 15,057 | 3,880,104 |
| Elk | 18 | 12,983 | 16 | 11,423 | 2 | 1,560 | 1,183 | 434,549 | 36,149 | 34,018 | 504,716 | 58,660 | 563,376 |
| Fayette | 84 | 49,272 | 83 | 49,072 | 1 | 200 | 6,569 | 2,620,702 | 545,604 | 489,438 | 3,655,744 | 45,259 | 3,701,003 |
| Huntingdon | 6 | 3,516 | 6 | 3,516 | | | 543 | 197,942 | 12,756 | 12,404 | 223,102 | | 223,102 |
| Indiana | 4 | 1,950 | 4 | 1,950 | | | 139 | 33,377 | 2,884 | 4,019 | 40,280 | 2,376 | 42,656 |
| Jefferson | 29 | 25,226 | 28 | 24,926 | 1 | 300 | 3,720 | 1,577,479 | 119,284 | 233,817 | 1,930,580 | 20,955 | 1,951,535 |
| Lawrence and McKean. | 7 | 4,850 | 7 | 4,850 | | | 295 | 110,173 | 5,040 | 12,265 | 127,478 | | 127,478 |
| Mercer | 17 | 11,143 | 17 | 11,143 | | | 1,095 | 381,742 | 47,658 | 41,130 | 470,530 | 693 | 471,223 |
| Somerset | 7 | 4,613 | 7 | 4,613 | | | 526 | 202,894 | 19,050 | 31,043 | 252,987 | | 252,987 |
| Tioga | 19 | 18,150 | 18 | 17,730 | 1 | 420 | 2,400 | 993,268 | 71,541 | 97,328 | 1,162,137 | | 1,162,137 |
| Washington | 44 | 31,090 | 41 | 30,100 | 3 | 990 | 3,977 | 1,396,666 | 94,392 | 69,606 | 1,560,664 | 21,222 | 1,581,886 |
| Westmoreland | 106 | 85,422 | 105 | 84,942 | 1 | 480 | 9,068 | 4,022,633 | 608,481 | 548,801 | 5,179,915 | 82,097 | 5,262,012 |

## VALUE AND POWER AT PENNSYLVANIA BITUMINOUS COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | Cash capital not reported in the foregoing items. | Total capital. | Number of animals employed. |
|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | | | |
| | Acres. | Value. | Acres. | Value. | | | | | | |
| Total | 132,811 | $21,817,269 | 98,025 | $16,281,741 | $7,118,900 | $5,020,101 | $50,238,011 | $3,084,319 | $53,322,330 | 5,383 |
| Allegheny | 16,359 | 4,287,120 | 7,046 | 1,461,376 | 1,576,437 | 889,342 | 8,214,275 | 570,998 | 8,785,273 | 698 |
| Armstrong | 1,473 | 169,300 | 669 | 54,175 | 47,444 | 28,522 | 299,441 | 22,700 | 322,141 | 41 |
| Beaver | 1,105 | 56,810 | 443 | 14,500 | 12,170 | 18,580 | 102,060 | 17,500 | 119,560 | 13 |
| Bedford | 860 | 125,000 | 1,830 | 440,600 | 49,700 | 53,000 | 668,300 | 30,350 | 698,650 | 81 |
| Blair and Bradford | 8,174 | 323,400 | 4,565 | 128,410 | 162,989 | 105,015 | 719,814 | 57,750 | 777,564 | 129 |
| Butler | 326 | 20,226 | 2,372 | 116,844 | 58,960 | 20,546 | 216,576 | 21,200 | 237,776 | 51 |
| Cambria and Cameron | 15,113 | 1,187,600 | 5,655 | 718,550 | 330,075 | 200,323 | 2,436,548 | 151,900 | 2,588,448 | 291 |
| Centre | 2,307 | 60,700 | 1,361 | 94,700 | 43,975 | 84,396 | 283,771 | 41,743 | 325,514 | 75 |
| Clarion and Clinton | 4,076 | 210,200 | 4,156 | 1,140,490 | 123,575 | 93,619 | 1,567,884 | 58,760 | 1,626,644 | 109 |
| Clearfield | 10,431 | 1,161,394 | 26,697 | 3,689,600 | 474,083 | 690,649 | 6,015,726 | 431,935 | 6,447,661 | 840 |
| Elk | 9,502 | 382,776 | 700 | 70,142 | 332,517 | 227,885 | 1,013,320 | 79,200 | 1,092,520 | 102 |
| Fayette | 10,085 | 3,209,250 | 6,822 | 2,001,000 | 822,355 | 537,045 | 6,569,650 | 368,962 | 6,938,612 | 874 |
| Huntingdon | 1,800 | 154,000 | 838 | 54,000 | 111,565 | 15,788 | 335,353 | 29,200 | 364,553 | 61 |
| Indiana | 896 | 142,860 | 50 | 5,000 | 39,244 | 14,421 | 201,525 | 8,350 | 209,875 | 13 |
| Jefferson | 9,536 | 1,089,340 | 11,500 | 1,213,461 | 493,520 | 360,354 | 3,156,675 | 180,937 | 3,337,612 | 359 |
| Lawrence and McKean | 241 | 18,300 | 1,722 | 112,068 | 65,233 | 38,582 | 234,183 | 23,700 | 257,883 | 28 |
| Mercer | 1,327 | 153,100 | 2,878 | 126,250 | 217,350 | 115,966 | 612,666 | 69,000 | 681,666 | 110 |
| Somerset | 2,238 | 335,907 | 2,345 | 140,350 | 74,980 | 36,966 | 588,203 | 29,647 | 617,850 | 49 |
| Tioga | 8,117 | 280,000 | 6,435 | 160,875 | 121,465 | 205,695 | 768,035 | 135,195 | 903,230 | 217 |
| Washington | 8,090 | 1,267,701 | 1,586 | 284,950 | 329,147 | 322,086 | 2,203,884 | 215,945 | 2,419,829 | 240 |
| Westmoreland | 20,755 | 7,182,285 | 8,355 | 4,254,400 | 1,632,116 | 961,321 | 14,030,122 | 539,347 | 14,569,469 | 1,002 |

## RHODE ISLAND.

According to Professor N. S. Shaler, of Cambridge, Massachusetts, who has recently examined the coal fields about Narragansett bay, this field contains a large and essentially unexplored coal basin which gives promise of great value. Professor Shaler has found that this basin contains several coal beds of workable thickness underlying a large area. The coal is exceedingly anthracitic, but has a heat-giving power of 80 per cent of the best Pennsylvania anthracite. The beds lie in much dislocated strata, and are in part rendered useless by the crumbling and cracking which have accompanied the foldings to which they have been subjected; still there are large areas where the beds lie in altitudes, rendering mining not difficult. The field has peculiar advantages for making water gas and smelting iron and copper, as the coal does not fill up a furnace to the extent of other anthracites and remains a long time in combustion. The percentage of sulphur is slight, and the proportion of ash is not greater than that of several coals extensively used in this country. This is the only coal field on the United States Atlantic coast which is actually on tide water. Nearly the whole basin is covered by a thick coating of rearranged glacial drift.

Dr. Charles A. Ashburner, in a paper prepared for the geological survey of the United States, states that the New England basin is estimated to contain 500 square miles of coal-producing territory. The original coal beds in this basin have been metamorphosed into graphite and graphitic coal, of which a considerable quantity has been mined at various times. The area includes eastern Rhode Island and the counties of Bristol and Plymouth, in Massachusetts. The graphitic character of the coal has resulted from the metamorphic action to which the beds and their associated strata have been subjected, which has expelled all the volatile matter originally contained in the coal, converting the bulk of the carbon into graphite. The product mined from the beds requires a considerable degree of heat for combustion, and can only be used in connection with other combustible material or under intense draft or blast.

The mining operations conducted during the year 1889 were as follows:

The New England Pipe Covering and Mining Company, Providence, Rhode Island, is opening up a quarry at Cranston, adjoining the old workings of the Carbon Iron Company of Pittsburg, which for some time had been mining at this point and shipping the product to Pittsburg for use in the reduction of iron ores to a metallic sponge. This has, however, been abandoned, and coke substituted for the purpose. The present company contemplates the mining and preparation of the product for the purposes of pipe coverings, stove facings, paints, lithographic stone, etc., and looks forward to an extensive business.

The Blackstone Coal Mining Company is operating the old mine at Valley Falls, which is reached by a slope some 300 feet deep, and produced about 1,000 tons during the year 1889. This product is ground and bolted at the mine and sold entirely for foundry purposes.

The Worcester Steel Company, at Worcester, Massachusetts, has for several years been in possession of the old Portsmouth mines, and during 1889 pumped out the shafts and began the mining of coal, which was shipped to their works and used under the boilers. This company also controls the iron-ore mines at Cumberland, Rhode Island, and it is the intention to construct a blast furnace at Portsmouth, when the coal, iron ore, limestone, and fire clay could be conveniently and cheaply brought together, thus insuring pig iron for their steel works at very low cost. This project has, however, been temporarily interrupted. The coal veins at Portsmouth range from 2.5 to 10 feet thick, lying in pockets in many places, showing much greater thickness. The quality of the coal seems to improve as greater depths are reached. The present openings are down 1,200 to 1,500 feet. The product during the year 1889 was reported as 2,000 tons, valued at $3 per ton at the mines.

## TENNESSEE.

The great Appalachian coal field passes through the state of Tennessee, bearing from northwest to southeast a width of about 70 miles westward from Cumberland Gap through the counties of Fentress, Scott, Campbell, and Claiborne at the north to Franklin and Marion counties, about 30 miles westward from the Tennessee river, at the south, and embraces 21 counties in which coal deposits are known to exist.

The local or trade divisions of the coal fields of the state are designated as follows:

### EAST TENNESSEE DIVISION.

Jellico district, Elk Valley district, Careyville district, and Big Creek district, Campbell county; Cumberland Gap district, Claiborne county; Poplar Creek district, Morgan county, and Coal Creek district, Anderson county.

### MIDDLE TENNESSEE DIVISION.

Sequatchie district, Marion county; Valley district, Hamilton county; Walden Ridge district, Rhea and Roane counties; Tracy City district, Grundy and Franklin counties, and Plateau district, Scott county.

Small local mines exist in several counties not named above, but the product is small and irregular, and is consumed mainly for domestic purposes and for smithing.

While the general character of the coal of the state is bituminous, considerable diversity exists in the different sections. In the northern portion high grades of gas and cannel coal are abundant, while to the southward the coal is more soft and friable and better adapted for coking and steam purposes.

No less than 18 distinct seams of coal have been identified in some of the higher points of the Cumberland mountains, but many of these are not of a character to permit development. The workable veins range from 2 to 7 feet in thickness, and generally belong to the upper measures.

Below is a list of the railroads which furnish transportation facilities for the Tennessee coals:

East Tennessee, Virginia and Georgia railway.
Cincinnati, New Orleans and Texas Pacific railway.
Alabama Great Southern railway.
Nashville, Chattanooga and Saint Louis railway.
Louisville and Nashville railway.

The product during the year ended June 30, 1880, as reported to the Tenth Census, was 495,131 short tons, valued at $629,724 at the mines, an average of $1.27 per ton. During the year 1889 the total production was 1,925,689 short tons, valued at $2,338,309 at the mines, an average of $1.21 per ton. The increase in production during the decade was nearly fivefold, while the value at the mines was nearly four times as great as in the previous census year.

The following table shows the total production of coal in Tennessee in 1889 and the disposition of the same:

COAL PRODUCT OF TENNESSEE IN 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | MINES. | | Total product of coal of all grades for 1889. | DISPOSITION OF TOTAL PRODUCT. | | | | | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Regular. | Local. | | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | Manufactured into coke. | | |
| Total | 39 | 43 | 1, 925, 689 | 1, 334, 424 | 13, 212 | 15, 889 | 23, 034 | 539, 130 | $2, 338, 309 | $1. 21 |
| Anderson | 7 | | 457, 069 | 442, 319 | | 9, 700 | 5, 050 | | 531, 920 | 1. 16 |
| Bledsoe | | 5 | 225 | | 225 | | | | 280 | 1. 24 |
| Campbell | 5 | 6 | 123, 103 | 117, 017 | 691 | 2, 985 | 1, 410 | 1, 000 | 146, 610 | 1. 19 |
| Claiborne (*a*) | 2 | | | | | | | | | |
| Cumberland | | 10 | 124 | | 124 | | | | 155 | 1. 25 |
| Fentress | | 5 | 25 | | 25 | | | | 30 | 1. 20 |
| Franklin, Roane, and White | 3 | | 174, 551 | 53, 608 | 1, 401 | 2, 118 | 10, 796 | 106, 628 | 318, 686 | 1. 83 |
| Grundy | 2 | 1 | 400, 107 | 253, 891 | 280 | 700 | 2, 100 | 143, 136 | 395, 767 | 0. 99 |
| Hamilton | 3 | | 241, 067 | 212, 845 | 893 | 60 | 2, 110 | 25, 159 | 313, 991 | 1. 30 |
| Marion | 5 | | 203. 923 | 103, 288 | 2, 663 | 11 | 633 | 97, 328 | 230, 116 | 1. 13 |
| Morgan | 6 | 3 | 68, 229 | 64, 037 | 3, 452 | 100 | 640 | | 91, 511 | 1. 34 |
| Overton and Putnam | | 2 | 10 | | 10 | | | | 10 | 1. 00 |
| Rhea | 3 | 2 | 149, 194 | 2, 000 | 1, 505 | 50 | | 145, 639 | 164, 118 | 1. 10 |
| Scott | 3 | 2 | 108, 027 | 85, 419 | 1, 908 | 165 | 295 | 20, 240 | 145, 075 | 1. 34 |
| Van Buren | | 2 | 10 | | 10 | | | | 10 | 1. 00 |
| Warren | | 5 | 25 | | 25 | | | | 30 | 1. 20 |

*a* Not operated in 1889.

The following table shows the office force employed and the amount expended in coal-mining operations during the year 1889:

EXPENDITURES AT TENNESSEE COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Total number of employés. | Total amount of wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| Total | 77 | $60, 918 | 74 | $59. 328 | 3 | $1, 590 | 4, 108 | $1, 609, 310 | $271, 390 | $219, 268 | $2, 099, 968 | $13, 324 | $2, 113, 292 |
| Anderson | 16 | 11, 100 | 15 | 10, 700 | 1 | 400 | 986 | 436, 354 | 100, 544 | 62, 256 | 599, 154 | | 599, 154 |
| Campbell | 13 | 14, 580 | 13 | 14, 580 | | | 393 | 117, 686 | 7, 483 | 8, 245 | 133, 414 | 800 | 134, 214 |
| Franklin, Roane, and White | 5 | 4, 846 | 5 | 4, 846 | | | 391 | 170, 614 | 14, 424 | 26, 864 | 211, 902 | | 211, 902 |
| Grundy | 5 | 6, 840 | 5 | 6, 840 | | | 501 | 210, 067 | 14, 752 | 15, 371 | 240, 190 | | 240, 190 |
| Hamilton | 16 | 8, 279 | 16 | 8, 279 | | | 625 | 204, 168 | 39, 440 | 48, 626 | 292, 234 | 9, 874 | 302, 108 |
| Marion | 7 | 5, 508 | 7 | 5, 508 | | | 422 | 183, 631 | 59, 597 | 36, 670 | 279, 898 | 150 | 280, 048 |
| Morgan | 2 | 1, 800 | 2 | 1, 800 | | | 135 | 39, 049 | 14, 850 | 12, 340 | 66, 239 | 2, 500 | 68, 739 |
| Rhea | 6 | 2, 700 | 6 | 2, 700 | | | 475 | 154, 452 | 3, 000 | 4, 171 | 161, 623 | | 161, 623 |
| Scott | 7 | 5, 265 | 5 | 4, 075 | 2 | 1, 190 | 180 | 93, 289 | 17, 300 | 4, 725 | 115, 314 | | 115, 314 |

The following table gives the value of Tennessee coal mines and improvements and the kinds of power employed at the mines:

VALUE OF AND POWER AT TENNESSEE COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | | | POWER USED IN MINING. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | Steam boilers. | | Number of animals. |
| | Acres. | Value. | Acres. | Value. | | | | | | Number. | Horse power. | |
| Total | 78,289 | $1,363,500 | 55,623 | $1,094,350 | $1,046,454 | $638,095 | $4,142,399 | $220.312 | $4,362,711 | 24 | 1,475 | 611 |
| Anderson | ........ | ........ | 3,665 | 392,500 | 80,500 | 38,200 | 511,200 | 58,800 | 570,000 | 4 | 140 | 132 |
| Campbell | 10,220 | 244,000 | 1,560 | 22,000 | 497,429 | 86,350 | 849,779 | 24,060 | 873,839 | ........ | ........ | 37 |
| Franklin, Roane, and White | 500 | 10,000 | 12,102 | 240,900 | 35,100 | 65,000 | 351,000 | 18,500 | 369,500 | 8 | 515 | 72 |
| Grundy | 13,700 | 205,500 | 20 | 400 | 10,100 | 27,321 | 243,321 | 23,200 | 266,521 | 4 | 400 | 110 |
| Hamilton | 2,514 | 25,000 | 20,065 | 195,000 | 92,000 | 181,854 | 493,854 | 32,700 | 526,554 | 2 | 160 | 115 |
| Marion | 39,855 | 775,000 | 500 | 12,500 | 153,275 | 58,470 | 999,245 | 25,650 | 1,024,895 | 2 | 80 | 46 |
| Morgan | ........ | ........ | 3,211 | 76,050 | 27,050 | 16,400 | 119,500 | 12,600 | 132,100 | ........ | ........ | 25 |
| Rhea | ........ | ........ | 14,500 | 155,000 | 85,000 | 140,000 | 380,000 | 13,700 | 393,700 | 3 | 160 | 54 |
| Scott | 11,500 | 104,000 | ........ | ........ | 66,000 | 24,500 | 194,500 | 11,102 | 205,602 | 1 | 20 | 20 |

The following table shows the labor employed at the mines, both above and below ground, the average wages paid per day, and the total amount of wages paid in 1889:

LABOR AND WAGES AT TENNESSEE COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mine. | ABOVE GROUND. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Total | 4,031 | 569 | 48 | $2.47 | 249 | 101 | $1.86 | 244 | 393 | $1.21 | 222 | 27 | $0.55 | 190 |
| Anderson | 970 | 143 | 17 | 2.22 | 252 | 13 | 1.80 | 262 | 113 | 1.27 | 235 | ........ | ........ | ........ |
| Campbell | 380 | 68 | 5 | 2.97 | 286 | 9 | 1.72 | 166 | 47 | 1.50 | 164 | 7 | 0.71 | 145 |
| Hamilton | 609 | 71 | 4 | 2.71 | 266 | 8 | 1.72 | 234 | 50 | 0.98 | 239 | 9 | 0.50 | 241 |
| Marion | 415 | 89 | 4 | 1.87 | 256 | 13 | 1.80 | 264 | 70 | 1.17 | 261 | 2 | 0.50 | 264 |
| Morgan | 133 | 23 | 5 | 1.80 | 191 | 2 | 1.88 | 210 | 15 | 1.22 | 134 | 1 | 0.40 | 70 |
| Other counties (*a*) | 1,524 | 175 | 13 | 2.89 | 245 | 56 | 1.92 | 251 | 98 | 1.19 | 213 | 8 | 0.54 | 168 |

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Total | 3,462 | 55 | $2.14 | 245 | 2,538 | $1.98 | 227 | 696 | $1.26 | 228 | 173 | $0.72 | 229 | $1,548,392 |
| Anderson | 827 | 8 | 2.36 | 268 | 713 | 1.89 | 246 | 89 | 1.65 | 242 | 17 | 1.02 | 233 | 425,254 |
| Campbell | 312 | 4 | 2.34 | 175 | 269 | 1.83 | 142 | 31 | 1.61 | 144 | 8 | 0.76 | 143 | 103,106 |
| Hamilton | 538 | 13 | 2.00 | 228 | 375 | 1.78 | 230 | 102 | 1.00 | 225 | 48 | 0.88 | 224 | 195,889 |
| Marion | 326 | 3 | 2.50 | 304 | 266 | 2.12 | 237 | 44 | 1.23 | 243 | 13 | 0.53 | 284 | 178,123 |
| Morgan | 110 | 4 | 2.21 | 213 | 92 | 2.10 | 165 | 14 | 1.33 | 94 | ........ | ........ | ........ | 37,249 |
| Other counties (*a*) | 1,349 | 23 | 2.04 | 256 | 823 | 2.12 | 241 | 416 | 1.22 | 235 | 87 | 0.60 | 230 | 608,771 |

*a* The counties here grouped, in order that the business of individual establishments may not be disclosed, are Franklin, Grundy, Rhea, Roane, Scott, and White.

## TEXAS.

The principal body of bituminous coal in Texas lies in the northern central portion of the state, extending southwest from the Red river, in Montague county, to the Colorado river. This basin is a continuation of the great Fourth or Western field, of which it forms the southern extremity. It is said to underlie the whole or portions of 25 counties, and embraces an area of 12,000 square miles. The only operation of importance in this field in the year 1889 was that of the Texas and Pacific Coal Company in Erath county. The field next in importance in this state lies along the Rio Grande, underlying Webb, Dimmit, Zavalla, Uvalde, Medina, and Maverick counties, known as the Nueces coal field, and embraces about 3,700 square miles. The quality here is variable, differing materially from that of the Central field, the lower measures yielding a fair semibituminous product, while the upper measures are somewhat lignitic. The principal developments in this field are at Santa Tomas, in Webb county, and at Eagle Pass, in Maverick county.

An extended area, bounded by lines drawn from Clarksburg, in Red River county, southwesterly to the Rio Grande, and thence northeast to the Sabine river, in Sabine county, is said to contain important deposits of lignite. No developments are reported in this field, except those of the North Texas Coal and Mining Company in Rains county.

The total quantity of coal of all grades mined in Texas during the year 1889 was 128,216 short tons, valued at $340,620 at the mines. The average number of persons employed during the year was 549, and the amount of wages paid $256,834.

No report of coal mining in Texas was made at the Tenth Census. The product, disposition, and value of the coal mined during 1889, the average price per ton received, the average number of persons employed, and the total amount paid in wages are shown in the following tables:

COAL PRODUCT OF TEXAS IN 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | Total product of coal of all grades for year 1889. | DISPOSITION OF TOTAL PRODUCT. | | | | MAXIMUM PRODUCTION FOR ANY ONE MONTH. | | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|---|
| | | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | Month. | Amount. | | |
| Total | 128,216 | 120,602 | 6,348 | 204 | 1,062 | | | $340,620 | $2.66 |
| Coleman | 10 | | 10 | | | | | 20 | 2.00 |
| Erath | 75,036 | 72,487 | 1,787 | | 762 | October | 9,926 | 210,103 | 2.80 |
| Jack | 330 | | 330 | | | | | 550 | 1.67 |
| McCulloch | 75 | | 75 | | | | | 375 | 5.00 |
| Maverick | 19,800 | 16,000 | 3,500 | 200 | 100 | October | 2,900 | 40,392 | 2.04 |
| Medina | 4,500 | 4,300 | | | 200 | July | 500 | 6,750 | 1.50 |
| Rains | 150 | | 146 | 4 | | | | 263 | 1.75 |
| Webb | 27,815 | 27,815 | | | | August | 3,251 | 80,667 | 2.90 |
| Wise | 500 | | 500 | | | | | 1,500 | 3.00 |

LABOR AND WAGES AT TEXAS COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mine. | ABOVE GROUND. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total average number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Erath, Maverick, Medina, and Webb. | 543 | 121 | 7 | $2.91 | 283 | 5 | $2.50 | 260 | 109 | $1.52 | 248 | | | |

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total average number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Erath, Maverick, Medina, and Webb. | 422 | 6 | $2.65 | 248 | 340 | $2.00 | 364 | 56 | $1.77 | 290 | 20 | $0.75 | 40 | $252,470 |

### EXPENDITURES AT TEXAS COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| Total | 6 | $4,364 | 6 | $4,364 | .......... | .......... | 549 | $256,834 | $54,333 | $12,990 | $324,157 | .......... | $324,157 |
| Erath, Maverick, and Webb. | 6 | 4,364 | 6 | 4,364 | .......... | .......... | 536 | 251,834 | 53,833 | 12,315 | 317,982 | .......... | 317,982 |
| Medina | .......... | .......... | .......... | .......... | .......... | .......... | 13 | 5,000 | 500 | 675 | 6,175 | .......... | 6,175 |

### VALUE OF AND POWER AT TEXAS COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | | | POWER USED IN MINING. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | Steam boilers. | | Number of cylinders. | Number of animals employed. |
| | Acres. | Value. | Acres. | Value. | | | | | | Number. | Horse power. | | |
| Total | 1,000 | $10,000 | 3,780 | $105,000 | $68,199 | $90,136 | $273,335 | $34,000 | $307,335 | 4 | 85 | 10 | 51 |
| Erath, Maverick, and Webb. | 1,000 | 10,000 | 2,500 | 85,000 | 67,699 | 88,636 | 251,335 | 33,300 | 284,635 | 3 | 70 | 9 | 48 |
| Medina | .......... | .......... | 1,280 | 20,000 | 500 | 1,500 | 22,000 | 700 | 22,700 | 1 | 15 | 1 | 3 |

## UTAH.

No systematic geological surveys of the territory have been made, and it is therefore impossible to state with any degree of accuracy the location or the extent of the areas underlaid by coal. It has been estimated that over 2,000 square miles contain coal of a workable character. The fields from which reports were made to the Eleventh Census were Grass creek, in Summit county, and Pleasant Valley, in Sanpete and Emery counties.

The Salt Lake Tribune thus describes the coal regions of Utah territory:

> The nearest coal fields to this city are about Coalville and along Chalk creek and the upper Weber, extending over to Provo, covering something over 50,000 acres. The veins are from 4 to 10 feet thick, and the coal is semibituminous. Emery county contains the most extensive coal lands. In the Book Cliff range, all the way from the Colorado line to the Wasatch, 130 miles, there are signs of coal, the upper face of the cliffs exposing a number of veins dipping northward 3° to 4°. These veins are from 4 to 12 feet thick, cut in almost every ravine or gulch cutting through the range, but have been opened at only a few points. The Castle Gate mines were developed the past year, and the 6-foot veins are sending out much coal, part of which is being converted into coke. From Price river southward past Huntington and Ferron creek, a distance of 60 miles through Emery, Sanpete, and Sevier counties, are immense bodies of coal, covering an average space of 12 by 60 miles in extent. The Pleasant Valley coal fields are located in this belt. The veins vary in thickness up to 20 feet, all lying on the east slope of the Wasatch range. Going south there is a break of 50 miles, when there comes another coal basin in Garfield and Iron counties. West of Kanarraville there are 3 or 4 strong measures of coal, 1 opened some years ago, being 11 feet thick. The Pine mountains, west of Kanarraville, are reported to have good coal, but the question has not been definitely settled.

Recent analyses of the coal mined in Emery county show 47.65 per cent fixed carbon, and 39.75 per cent volatile matter. Tests made recently by the quartermaster general of the United States army show that in generating steam 2,407 pounds of coal were equivalent to 1 cord of standard oak wood.

The quantity of coal mined in the territory of Utah during the year ended June 30, 1880, as reported to the Tenth Census, was 14,748 short tons, valued at $33,645 at the mines. During the calendar year 1889 the total output, as reported to the Eleventh Census, was 236,651 short tons, valued at $377,456 at the mines. 4 regular establishments were in operation, and 565 persons employed.

### PRODUCT OF UTAH COAL MINES IN 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | Total product of coal of all grades for year 1889. | DISPOSITION OF TOTAL PRODUCT. | | | | | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|
| | | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | Manufactured into coke. | | |
| Total | 236,651 | 216,960 | 15,050 | 2,012 | 412 | 2,217 | $377,456 | $1.59 |
| Emery | 194,102 | 181,956 | 9,489 | 28 | 412 | 2,217 | 300,263 | 1.55 |
| Summit | 37,684 | 35,004 | 736 | 1,944 | .......... | .......... | 66,061 | 1.75 |
| Other counties | 4,865 | .......... | 4,825 | 40 | .......... | .......... | 11,132 | 2.29 |

## LABOR AND WAGES AT UTAH COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mine. | ABOVE GROUND. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total average number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Emery and Summit. | 551 | 84 | 3 | $3.63 | 246 | 18 | $2.84 | 238 | 59 | $2.35 | 198 | 4 | $0.97 | 252 |

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total average number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Emery and Summit. | 467 | 5 | $3.47 | 260 | 332 | $3.21 | 163 | 101 | $2.51 | 169 | 29 | $1.00 | 168 | $258,601 |

## EXPENDITURES AT UTAH COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| Total | 14 | $9,969 | 12 | $9,834 | 2 | $135 | 565 | $268,570 | $65,911 | $5,417 | $339,898 | $2,898 | $342,796 |
| Emery | 13 | 9,069 | 11 | 8,934 | 2 | 135 | 448 | 206,251 | 60,109 | 938 | 267,298 | 1,765 | 269,063 |
| Morgan | | | | | | | | | | | | | |
| Sanpete | | | | | | | | | | | | | |
| Summit | 1 | 900 | 1 | 900 | | | 117 | 62,319 | 5,802 | 4,479 | 72,600 | 1,133 | 73,733 |

## VALUE OF AND POWER AT UTAH COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | | | POWER USED IN MINING. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | Steam boilers. | | Number of cylinders. | Number of animals employed. |
| | Acres. | Value. | Acres. | Value. | | | | | | Number. | Horse power. | | |
| Total | 5,910 | $509,926 | | | $171,637 | $107,397 | $788,960 | $55,600 | $844,560 | 4 | 190 | 8 | 57 |
| Emery | 5,430 | 313,425 | | | 163,962 | 61,573 | 538,960 | 49,000 | 587,960 | 1 | 50 | 1 | 42 |
| Morgan | | | | | | | | | | | | | |
| Sanpete | | | | | | | | | | | | | |
| Summit | 480 | 196,501 | | | 7,675 | 45,824 | 250,000 | 6,600 | 256,600 | 3 | 140 | 7 | 15 |

## VIRGINIA.

The bituminous coal fields of Virginia may be divided into 3 prominent areas: First, the Richmond coal field, embracing the counties of Henrico, Chesterfield, Goochland, Powhatan, and Amelia, with traces in Hanover and Dinwiddie, situated in the triassic sandstone areas in the vicinity of Richmond. The coal from this field is a bright black bituminous, varying materially in hardness and quantities of impurities. In that part of the field lying north of the James river an unusual and interesting formation of natural coke exists, which bears a striking resemblance to the artificial product and is found to be a very desirable domestic fuel. Second, the Middle or subcarboniferous coal fields, along the western border of the state, in that portion designated the Appalachia. No mining operations have as yet been opened in this district. Third, the Pocahontas coal field, which embraces parts of Buchanan, Dickenson, Lee, Russell, Scott, Tazewell, and Wise counties, at the southern edge of the famous Flat Top region, including the Clinch Valley field, containing the lower productive coal measures of the Appalachian field. The finest grades of steam, gas, and coking coals are obtained from these districts, and the exceptional transportation facilities provided by the Norfolk and Western Railroad system to the westward and to tide water at Norfolk have distinguished this region as one of the most important in the country.

The total bituminous coal output of the state of Virginia during the year ended June 30, 1880, as reported to the Tenth Census, was 43,079 short tons, valued at $99,802 at the mines. During the calendar year 1889 the quantity mined in the state, as reported to the Eleventh Census, was 865,786 short tons, valued at $804,475, an average of 93 cents per ton, at the mines. This great increase during the decade is attributed entirely to the developments in the Flat Top and Clinch Valley districts.

The following table gives the total production of coal in Virginia in 1889 and the disposition of the same:

### COAL PRODUCT OF VIRGINIA IN 1889, BY COUNTIES

[Short tons.]

| COUNTIES. | MINES. |  | Total product of coal of all grades for 1889. | DISPOSITION OF TOTAL PRODUCT. |  |  |  |  | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|---|---|
|  | Regular. | Local. |  | Loaded at mines for shipment on railroad cars. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | Manufactured into coke. |  |  |
| Total | 11 | 47 | 865, 786 | 732, 881 | 7, 546 | 5, 633 | 7, 516 | 112, 210 | $804, 475 | $0. 93 |
| Buchanan |  | 3 | 169 |  | 89 | 80 |  |  | 345 | 2. 04 |
| Chesterfield and Henrico | 3 |  | 49, 411 | 44, 648 | 798 | 45 | 3, 920 |  | 77, 692 | 1. 57 |
| Dickenson |  | 4 | 35 |  | 23 | 12 |  |  | 106 | 3. 03 |
| Lee and Wythe |  | 4 | 370 |  | 370 |  |  |  | 703 | 1. 90 |
| Montgomery | 5 | 7 | 8, 165 | 3, 062 | 4, 642 | 226 | 235 |  | 19, 644 | 2. 41 |
| Pulaski and Tazewell | 3 | 23 | 807, 046 | 685, 171 | 1, 062 | 5, 242 | 3, 361 | 112, 210 | 705, 121 | 0. 87 |
| Russell |  | 2 | 402 |  | 398 | 4 |  |  | 603 | 1. 50 |
| Wise |  | 4 | 188 |  | 164 | 24 |  |  | 261 | 1. 39 |

The following table shows the office force employed and the amount expended in coal-mining operations during the year 1889:

### EXPENDITURES AT VIRGINIA COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. |  |  |  |  |  | Total number of employés. | Total amount of wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | Total. |  | Males. |  | Females. |  |  |  |  |  |  |  |  |
|  | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. |  |  |  |  |  |  |  |
| Total | 32 | $16, 470 | 27 | $14, 370 | 5 | $2, 100 | 1, 555 | $621, 266 | $46, 754 | $13, 456 | $681, 476 | $932 | $682, 408 |
| Chesterfield and Henrico | 5 | 1, 220 | 5 | 1, 220 |  |  | 257 | 62, 268 | 6, 500 | 5, 584 | 74, 352 |  | 74, 352 |
| Montgomery | 2 | 850 | 2 | 850 |  |  | 56 | 9, 935 | 4, 275 | 2, 200 | 16, 410 |  | 16, 410 |
| Pulaski and Tazewell | 25 | 14, 400 | 20 | 12, 300 | 5 | 2, 100 | 1, 242 | 549, 063 | 35, 979 | 5, 672 | 590, 714 | 932 | 591, 646 |

The following table shows the value of Virginia mines and improvements and the kind of power employed at the mines:

### VALUE OF AND POWER AT VIRGINIA COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. |  |  |  |  |  |  |  |  | POWER USED IN MINING. |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | In land owned. |  | In land leased. |  | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | Steam boilers. |  | Number of cylinders. | Other power. |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  | Motors. |  | Number of animals. |
|  | Acres. | Value. | Acres. | Value. |  |  |  |  |  | Number. | Horse power. |  | Number. | Horse power. |  |
| Total | 13, 900 | $290, 100 | 3, 790 | $103, 600 | $363, 270 | $273, 168 | $1, 030, 138 | $25, 378 | $1, 055, 516 | 57 | 1, 234 | 20 | 7 | 180 | 109 |
| Chesterfield and Henrico | 2, 200 | 40, 000 | 2, 100 | 50, 800 | 165, 000 | 46, 000 | 301, 800 | 9, 500 | 311, 300 | 37 | 455 | 8 |  |  | 7 |
| Montgomery | 200 | 2, 100 | 1, 690 | 52, 800 | 3, 900 | 1, 600 | 60, 400 | 2, 130 | 62, 530 | 2 | 39 | 1 |  |  | 4 |
| Pulaski and Tazewell | 11, 500 | 248, 000 |  |  | 194, 370 | 225, 568 | 667, 938 | 13, 748 | 681, 686 | 18 | 740 | 11 | 7 | 180 | 98 |

The following table shows the labor employed at the mines, both above and below ground, the average wages paid per day, and the total amount of wages paid in 1889:

LABOR AND WAGES AT VIRGINIA COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mines. | ABOVE GROUND. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Total | 1,523 | 521 | 16 | $1.99 | 245 | 51 | $2.04 | 269 | 407 | $1.16 | 282 | 47 | $0.51 | 210 |
| Chesterfield and Henrico. | 252 | 121 | 4 | 1.94 | 205 | 12 | 1.61 | 202 | 65 | 0.88 | 210 | 40 | 0.45 | 202 |
| Montgomery | 54 | 19 | 5 | 1.30 | 195 | 2 | 1.25 | 125 | 9 | 0.81 | 176 | 3 | 0.40 | 200 |
| Pulaski and Tazewell. | 1,217 | 381 | 7 | 2.32 | 304 | 37 | 2.15 | 298 | 333 | 1.20 | 299 | 4 | 1.00 | 300 |

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Total | 1,002 | 12 | $2.44 | 265 | 712 | $1.53 | 285 | 253 | $1.59 | 269 | 25 | $1.14 | 274 | $604,796 |
| Chesterfield and Henrico. | 131 | 3 | 2.17 | 206 | 68 | 1.95 | 210 | 55 | 1.05 | 196 | 5 | 0.75 | 168 | 61,048 |
| Montgomery | 35 | 2 | 1.38 | 200 | 28 | 0.96 | 177 | 5 | 0.87 | 155 | | | | 9,085 |
| Pulaski and Tazewell. | 836 | 7 | 2.71 | 308 | 616 | 1.51 | 298 | 193 | 1.70 | 293 | 20 | 1.20 | 300 | 534,663 |

## WASHINGTON.

The mining of coal in the state of Washington began about the year 1850–1851, in the field in the vicinity of Bellingham bay, in the extreme northwestern part of the territory, but operations there were discontinued in 1879, and have not been resumed. Several important coal areas have since been opened up both on the western and eastern slopes of the Cascade range, the most important of which are in the vicinity of Puget sound, in King, Pierce, and Thurston counties, and in Yakima county near the Attanam river. Outcroppings have been found in other localities, notably at Ellensburg, and in Lincoln and Spokane counties, and also on White Salmon river, in Cascade county. The coals of this state embrace lignite, semibituminous, and bituminous varieties, adapted for coking, gas, steam, and domestic purposes. Some specimens of a very fine grade of coal resembling anthracite are reported as having been taken from Cowlitz pass, in Yakima county. The total area of the coal deposits of Washington has not yet been fully determined, but there is no doubt that almost inexhaustible supplies are at hand, not only for the future demand of its own population, but sufficient to furnish a basis for profitable traffic for transportation to the entire Pacific coast. The total product for the calendar year 1889 was 1,030,578 short tons, valued at $2,393,238, showing an average of $2.32 per ton, at the mines. The average number of persons employed was 2,695, and the total amount of wages paid was $1,747,080.

PRODUCT OF WASHINGTON COAL MINES IN 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | Total product of coal of all grades for year 1889. | DISPOSITION OF TOTAL PRODUCT. | | | | | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|
| | | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | Manufactured into coke. | | |
| Total | 1,030,578 | 956,046 | 11,036 | 4,538 | 19,958 | 39,000 | $2,393,238 | $2.32 |
| King | 415,779 | 398,657 | 3,121 | 2,410 | 11,591 | | 954,295 | 2.30 |
| Kittitas | 294,701 | 289,300 | 1,643 | | 3,758 | | 777,450 | 2.64 |
| Pierce | 273,618 | 228,889 | 672 | 1,008 | 4,049 | 39,000 | 578,493 | 2.11 |
| Thurston | 46,480 | 39,200 | 5,600 | 1,120 | 560 | | 83,000 | 1.79 |

### LABOR AND WAGES AT WASHINGTON COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mine. | ABOVE GROUND. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total average number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Total | 2, 657 | 540 | 21 | $3. 76 | 293 | 94 | $3. 04 | 255 | 396 | $2. 29 | 242 | 29 | $1. 41 | 214 |
| King | 1, 220 | 270 | 10 | 4. 00 | 278 | 30 | 2. 97 | 227 | 210 | 2. 20 | 230 | 20 | 1. 43 | 224 |
| Kittitas and Thurston | 678 | 110 | 5 | 3. 18 | 340 | 30 | 2. 96 | 326 | 73 | 2. 49 | 327 | 2 | 1. 26 | 241 |
| Pierce | 759 | 160 | 6 | 3. 94 | 280 | 34 | 3. 22 | 218 | 113 | 2. 26 | 210 | 7 | 1. 38 | 177 |

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total average number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Total | 2, 117 | 31 | $3. 97 | 286 | 1, 549 | $3. 26 | 197 | 509 | $2. 46 | 222 | 28 | $1. 06 | 222 | $1, 696, 293 |
| King | 950 | 15 | 4. 06 | 279 | 524 | 3. 77 | 214 | 391 | 2. 43 | 223 | 20 | 1. 01 | 229 | 796, 007 |
| Kittitas and Thurston | 568 | 7 | 3. 42 | 342 | 545 | 2. 88 | 235 | 16 | 2. 61 | 297 | | | | 542, 740 |
| Pierce | 599 | 9 | 4. 40 | 253 | 480 | 3. 14 | 134 | 102 | 2. 54 | 208 | 8 | 1. 22 | 203 | 357, 546 |

### EXPENDITURES AT WASHINGTON COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| Total | 38 | 50, 787 | 37 | 50, 487 | 1 | 300 | 2, 695 | $1, 747, 080 | $287, 211 | $210, 899 | $2, 245, 190 | $9, 296 | $2, 254, 486 |
| King, Kittitas, and Thurston. | 23 | 26, 808 | 23 | 26, 808 | | | 1, 921 | 1, 365, 555 | 258, 476 | 196, 315 | 1, 820, 346 | 9, 296 | 1, 829, 642 |
| Pierce | 15 | 23, 979 | 14 | 23, 679 | 1 | 300 | 774 | 381, 525 | 28, 735 | 14, 584 | 424, 844 | | 424, 844 |

### VALUE OF AND POWER AT WASHINGTON COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUES OF MINES AND IMPROVEMENTS. | | | | | | | | | POWER USED IN MINING. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | Steam boilers. | | Other power. | | | | |
| | | | | | | | | | | | | Motors. | | Machines. | | Number of animals employed. |
| | Acres. | Value. | Acres. | Value. | | | | | | Number. | Horse power. | Number. | Horse power. | Number. | Kind. | |
| Total | 20, 322 | $1, 724, 000 | 2, 876 | $95, 760 | $326, 984 | $746, 903 | $2, 893, 647 | $292, 794 | $3, 186, 441 | 53 | 3, 050 | 3 | 35 | 1 | | 193 |
| King, Kittitas, and Thurston. | 14, 882 | 1, 584, 000 | 516 | 17, 760 | 215, 988 | 590, 559 | 2, 408, 307 | 222, 694 | 2, 631, 001 | 43 | 2, 640 | | | 1 | Diamond | 160 |
| Pierce | 5, 440 | 140, 000 | 2, 360 | 78, 000 | 110, 996 | 156, 344 | 485, 340 | 70, 100 | 555, 440 | 10 | 410 | 3 | 35 | | | 33 |

## WEST VIRGINIA.

The Appalachian field passes southward from the Pennsylvania state line, covering almost the entire state of West Virginia. A detached arm, extending southwestward through Allegany and Garrett counties, Maryland, and Mineral and Grant counties, West Virginia, constitutes what is known as the Elk Garden district. This basin continues southwestward through Tucker and Randolph counties along the valley of the Otter Fork creek. 9 distinct seams underlie this district, including the Big Vein, which has a thickness of from 14 to 16 feet, the others varying from 2.5 to 7 feet, all being of a character to admit of profitable development. The main body of this great field in West Virginia lies between a line drawn from the Maryland state line in Preston county southwestward through Mercer county to the Virginia state line and the western boundary of the state, and includes all but 6 of the 54 counties, although mining operations on a commercial scale are carried on in only 16 counties.

The coal measures of West Virginia are a continuation of those described in Pennsylvania. The Pittsburg bed, at the bottom of the upper productive measures, is found in the northern portion, the middle coal measures in the Kanawha valley region, and the lower coal measures in the Flat Top region. No state in the Union is more favored in the extent and diversity of its mineral deposits than West Virginia. Her coal embraces all grades of bituminous—steam, coking, and gas coals of the highest qualities. The natural water ways, improved slack-water navigation, and increasing railroad facilities are important factors in the development of the resources of the state, which must soon be accorded a leading position in wealth and industrial prosperity.

The coal product of West Virginia for the year ended June 30, 1880, as reported to the Tenth Census, was 1,829,844 short tons, valued at $2,013,671, an average of $1.10 per ton, at the mines. The quantity mined during the calendar year 1889, as reported to the Eleventh Census, was 6,231,880 short tons, valued at $5,086,584, an average of 82 cents per ton, at the mines.

The following table gives the total production of coal in West Virginia in 1889 and the disposition of the same:

COAL PRODUCT OF WEST VIRGINIA IN 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | MINES. | | Total product of coal of all grades for 1889. | DISPOSITION OF TOTAL PRODUCT. | | | | | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Regular. | Local. | | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | Manufactured into coke. | | |
| Total | 115 | 996 | 6,231,880 | 4,764,900 | 448,527 | 44,760 | 37,368 | 936,325 | $5,086,584 | $0.82 |
| Barbour | | 3 | 1,600 | | 1,600 | | | | 1,200 | 0.75 |
| Boone | | 167 | 2,888 | | 2,888 | | | | 2,293 | 0.79 |
| Braxton | | 3 | 160 | | 160 | | | | 120 | 0.75 |
| Brooke | 2 | 8 | 31,119 | 14,035 | 16,831 | 103 | 150 | | 22,828 | 0.73 |
| Cabell | | 5 | 505 | | 505 | | | | 485 | 0.96 |
| Calhoun | | 5 | 220 | | 220 | | | | 165 | 0.75 |
| Clay | | 17 | 256 | | 256 | | | | 192 | 0.75 |
| Fayette | 28 | 35 | 1,450,780 | 1,074,409 | 12,211 | 11,468 | 7,150 | 345,542 | 1,302,438 | 0.90 |
| Gilmer | | [illegible] | 820 | | 820 | | | | 615 | 0.75 |
| Harrison | 8 | 281 | 174,115 | 141,343 | 26,328 | 1,200 | 11 | 5,233 | 114,427 | 0.66 |
| Kanawha | 21 | 20 | 1,218,236 | 1,168,024 | 31,393 | 10,614 | 3,529 | 4,676 | 1,166,038 | 0.96 |
| Lewis | | 2 | 60 | | 60 | | | | 30 | 0.50 |
| Lincoln | | 11 | 284 | | 284 | | | | 213 | 0.75 |
| Logan | | 19 | 3,456 | | 3,456 | | | | 2,592 | 0.75 |
| McDowell | 7 | | 586,529 | 309,489 | 56,620 | 4,788 | 3,265 | 212,367 | 390,232 | 0.67 |
| Marion | 5 | 122 | 282,467 | 157,975 | 24,066 | 974 | 1,932 | 97,520 | 199,692 | 0.71 |
| Marshall | 2 | 7 | 47,706 | 33,000 | 14,106 | | 600 | | 35,956 | 0.75 |
| Mason | 12 | 11 | 185,030 | 83,116 | 96,844 | 3,613 | 1,457 | | 167,783 | 0.91 |
| Mercer | 6 | 3 | 921,741 | 750,507 | 13 | 4,302 | 1,858 | 165,061 | 594,885 | 0.65 |
| Mineral | 4 | 1 | 493,464 | 487,622 | 3,862 | 1,924 | 56 | | 394,827 | 0.80 |
| Monongalia | 1 | 106 | 74,031 | 64,927 | 7,177 | 438 | 1,489 | | 53,318 | 0.72 |
| Monroe | | 3 | 30 | | 30 | | | | 23 | 0.77 |
| Nicholas | | 17 | 1,408 | | 1,408 | | | | 1,056 | 0.75 |
| Ohio | 7 | 23 | 143,170 | 28,121 | 113,615 | 1,020 | 414 | | 126,909 | 0.89 |
| Pocahontas | | 2 | 240 | | 240 | | | | 180 | 0 75 |
| Preston | 4 | 34 | 129,932 | 41,807 | 3,893 | 2,156 | 5,124 | 76,952 | 86,024 | 0.66 |
| Putnam | 4 | 12 | 218,752 | 210,214 | 6,140 | 1,384 | 1,014 | | 244,203 | 1.12 |
| Raleigh | | 4 | 1,480 | | 1,480 | | | | 1,110 | 0.75 |
| Ritchie | | 2 | 1,627 | | 1,528 | 36 | 63 | | 998 | 0.61 |
| Taylor | [illegible] | 7 | 83,012 | 58,318 | 16,685 | 337 | 21 | 7,651 | 52,725 | 0.64 |
| Tucker | 2 | | 173,492 | 141,993 | 538 | 403 | 9,235 | 21,323 | 120,574 | 0.69 |
| Tyler | | 1 | 12 | | 12 | | | | 9 | 0.75 |
| Upshur | | 33 | 2,114 | | 2,114 | | | | 1,586 | 0.75 |
| Wayne | | 5 | 880 | | 880 | | | | 660 | 0.75 |
| Wetzel | | 18 | 264 | | 264 | | | | 198 | 0.75 |

The following table shows the office force employed and the amount expended in coal-mining operations during the year 1889:

EXPENDITURES AT WEST VIRGINIA COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Total number of employés. | Total amount of wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| Total | 174 | $139, 991 | 173 | $139, 540 | 1 | $451 | 9, 952 | $3, 888, 712 | $462, 591 | $443, 394 | $4, 794, 697 | $47, 099 | $4, 841, 796 |
| Brooke | 2 | 868 | 2 | 868 | ...... | ........... | 50 | 17, 805 | 1, 025 | 1, 450 | 20, 280 | .......... | 20, 280 |
| Fayette | 54 | 43, 362 | 54 | 43, 362 | ...... | ........... | 2, 644 | 1, 073, 540 | 139, 427 | 124, 307 | 1, 337, 274 | 6, 483 | 1, 343, 757 |
| Harrison | 6 | 3, 320 | 6 | 3, 320 | ...... | ........... | 233 | 64, 488 | 6, 620 | 5, 632 | 76, 740 | 846 | 77, 586 |
| Kanawha | 38 | 37, 468 | 38 | 37, 468 | ...... | ........... | 2, 484 | 975, 936 | 108, 186 | 90, 511 | 1, 174, 633 | 10, 235 | 1, 184, 868 |
| McDowell | 16 | 11, 194 | 16 | 11, 194 | ...... | ........... | 764 | 301, 634 | 17, 498 | 36, 752 | 355, 884 | 771 | 356, 655 |
| Marion | 7 | 4, 469 | 6 | 4, 018 | 1 | 451 | 333 | 118, 289 | 12, 262 | 15, 692 | 146, 243 | .......... | 146, 243 |
| Marshall | 2 | 1, 000 | 2 | 1, 000 | ...... | ........... | 72 | 29, 500 | 3, 000 | 1, 600 | 34, 100 | .......... | 34, 100 |
| Mason | 9 | 4, 754 | 9 | 4, 754 | ...... | ........... | 363 | 128, 052 | 18, 252 | 36, 959 | 183, 263 | .......... | 183, 263 |
| Mercer | 16 | 14, 027 | 16 | 14, 027 | ...... | ........... | 1, 121 | 415, 348 | 70, 652 | 73, 615 | 559, 615 | .......... | 559, 615 |
| Mineral | 3 | 1, 960 | 3 | 1, 960 | ...... | ........... | 608 | 261, 105 | 18, 242 | 3, 668 | 283, 015 | 12, 414 | 295, 429 |
| Monongalia | 1 | 160 | 1 | 160 | ...... | ........... | 61 | 25, 930 | 3, 475 | 2, 500 | 31, 905 | .......... | 31, 905 |
| Ohio | 4 | 1, 920 | 4 | 1, 920 | ...... | ........... | 204 | 88, 056 | 6, 101 | 8, 644 | 102, 801 | .......... | 102, 801 |
| Preston | 4 | 3, 879 | 4 | 3, 879 | ...... | ........... | 239 | 85, 290 | 11, 465 | 7, 809 | 104, 564 | .......... | 104, 564 |
| Putnam | 6 | 7, 620 | 6 | 7, 620 | ...... | ........... | 451 | 171, 202 | 25, 989 | 24, 055 | 221, 246 | 11, 350 | 232, 596 |
| Taylor | 3 | 2, 610 | 3 | 2, 610 | ...... | ........... | 96 | 37, 957 | 6, 174 | 5, 200 | 49, 331 | .......... | 49, 331 |
| Tucker | 3 | 1, 380 | 3 | 1, 380 | ...... | ........... | 229 | 94, 580 | 14, 223 | 5, 000 | 113, 803 | 5, 000 | 118, 803 |

The following table gives the value of mines and improvements and the kind of power used at the mines:

VALUE OF AND POWER AT WEST VIRGINIA COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | | | POWER USED IN MINING. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | Steam boilers. | | Other power. | | |
| | | | | | | | | | | | | Motors. | | Number of animals employed. |
| | Acres. | Value. | Acres. | Value. | | | | | | Number. | Horse power. | Number. | Horse power. | |
| Total | 61, 531 | $3, 694, 987 | 45, 990 | $2, 806, 280 | $2, 160, 249 | $1, 255, 965 | $9, 917, 481 | $590, 569 | $10, 508, 050 | 62 | 1, 815 | 8 | 320 | 1. 305 |
| Brooke | ........ | ............ | 505 | 20, 500 | 1, 800 | 3, 530 | 25, 800 | 2, 500 | 28, 300 | ...... | ........ | ...... | ........ | 5 |
| Fayette | 18, 903 | 1. 023, 221 | 13, 102 | 831, 930 | 1, 015, 189 | 279, 464 | 3, 149, 804 | 187. 190 | 3, 336, 994 | 5 | 160 | ...... | ........ | 389 |
| Harrison | 1, 972 | 107, 910 | 160 | 8, 000 | 28, 340 | 21, 990 | 166, 240 | 9, 450 | 175, 690 | ...... | ........ | ...... | ........ | 42 |
| Kanawha | 17, 408 | 393, 948 | 16, 970 | 1, 161, 732 | 388, 626 | 188, 823 | 2, 133, 129 | 142, 550 | 2, 275, 679 | 8 | 270 | 3 | 110 | 313 |
| McDowell | 2, 883 | 468, 800 | 2, 720 | 146, 953 | 159, 102 | 149, 346 | 924, 201 | 43, 644 | 967, 845 | 12 | 395 | 1 | 25 | 63 |
| Marion | 2, 855 | 356, 667 | ....... | ............ | 48, 290 | 14, 890 | 419, 847 | 14, 200 | 434, 047 | 3 | 90 | ...... | ........ | 41 |
| Marshall | ........ | ............ | 320 | 2, 000 | 42, 000 | 9, 700 | 53, 700 | 3, 250 | 56, 950 | 3 | 150 | ...... | ........ | 8 |
| Mason | 1, 045 | 136, 125 | 2, 220 | 72, 750 | 35, 050 | 44, 505 | 288, 430 | 15, 900 | 304, 330 | 6 | 149 | 3 | 135 | 80 |
| Mercer | ........ | ............ | 3, 677 | 228, 055 | 151, 446 | 228, 755 | 608, 256 | 68, 197 | 676, 453 | 12 | 210 | ...... | ........ | 108 |
| Mineral | 5, 635 | 616, 337 | 800 | 2, 860 | 29, 048 | 25, 709 | 673, 954 | 28, 338 | 702, 292 | ...... | ........ | ...... | ........ | 57 |
| Monongalia | 15 | 2, 500 | ....... | ............ | 5, 000 | 1, 500 | 9, 000 | 3, 000 | 12, 000 | 1 | 15 | ...... | ........ | 4 |
| Ohio | 1, 587 | 61, 316 | 256 | 34, 000 | 12, 000 | 28, 000 | 135, 316 | 13, 250 | 148, 566 | 2 | 70 | ...... | ........ | 55 |
| Preston | 4, 207 | 393, 120 | 700 | 14, 000 | 78, 800 | 59, 375 | 545, 295 | 10, 200 | 555, 495 | 9 | 286 | ...... | ........ | 47 |
| Putnam | 3, 816 | 74, 543 | 3, 760 | 223, 500 | 103, 358 | 134, 608 | 536, 009 | 31, 500 | 567, 509 | ...... | ........ | ...... | ........ | 51 |
| Taylor | 205 | 20, 500 | ....... | ............ | 12, 200 | 25, 800 | 58, 500 | 4, 400 | 62, 900 | 1 | 20 | 1 | 50 | 16 |
| Tucker | 1, 000 | 40, 000 | 1, 000 | 60, 000 | 50, 000 | 40, 000 | 190, 000 | 13, 000 | 203, 000 | ...... | ........ | ...... | ........ | 26 |

The following table shows the labor employed at the mines, both above and below ground, the average wages per day, and the total amount of wages paid in 1889:

LABOR AND WAGES AT WEST VIRGINIA COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mines. | ABOVE GROUND. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Total | 9,778 | 1,558 | 117 | $2.48 | 270 | 244 | $1.90 | 246 | 1,135 | $1.36 | 211 | 62 | $0.76 | 203 |
| Fayette | 2,590 | 362 | 29 | 2.50 | 267 | 39 | 2.15 | 227 | 290 | 1.40 | 220 | 4 | 0.63 | 208 |
| Harrison | 227 | 42 | 2 | 1.50 | 121 | 4 | 1.85 | 163 | 26 | 1.13 | 219 | 10 | 1.00 | 200 |
| Kanawha | 2,446 | 504 | 26 | 2.41 | 287 | 66 | 1.90 | 263 | 391 | 1.37 | 215 | 21 | 0.73 | 238 |
| McDowell | 748 | 88 | 9 | 2.39 | 268 | 32 | 1.93 | 274 | 42 | 1.30 | 235 | 5 | 0.77 | 187 |
| Marion | 326 | 56 | 5 | 2.30 | 286 | 10 | 1.63 | 231 | 39 | 1.13 | 222 | 2 | 0.90 | 200 |
| Mason | 354 | 51 | 9 | 1.79 | 254 | 11 | 1.76 | 264 | 29 | 1.28 | 238 | 2 | 0.50 | 263 |
| Mercer | 1,105 | 146 | 8 | 3.44 | 290 | 19 | 1.98 | 243 | 113 | 1.40 | 130 | 6 | 0.50 | 172 |
| Mineral | 605 | 74 | 4 | 2.00 | 220 | 9 | 1.85 | 220 | 55 | 1.46 | 252 | 6 | 1.10 | 150 |
| Ohio | 200 | 19 | 3 | 2.46 | 284 | 6 | 1.50 | 240 | 10 | 1.39 | 223 | ........ | ........ | ........ |
| Preston | 235 | 40 | 3 | 2.25 | 204 | 8 | 1.71 | 235 | 27 | 1.19 | 197 | 2 | 0.63 | 128 |
| Putnam | 445 | 103 | 10 | 2.87 | 288 | 23 | 1.84 | 237 | 69 | 1.36 | 208 | 1 | 0.50 | 150 |
| Other counties (*a*) | 497 | 73 | 9 | 2.42 | 279 | 17 | 1.77 | 222 | 44 | 1.33 | 230 | 3 | 0.57 | 195 |

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Total | 8,220 | 118 | $2.46 | 269 | 6,367 | $1.86 | 223 | 1,504 | $1.47 | 224 | 231 | $0.66 | 220 | $3,748,721 |
| Fayette | 2,228 | 28 | 2.60 | 273 | 1,624 | 1.99 | 219 | 508 | 1.40 | 222 | 68 | 0.75 | 219 | 1,030,178 |
| Harrison | 185 | 3 | 1.75 | 219 | 155 | 1.52 | 196 | 23 | 1.28 | 157 | 4 | 1.00 | 200 | 61,168 |
| Kanawha | 1,942 | 23 | 2.48 | 280 | 1,519 | 1.79 | 232 | 328 | 1.56 | 223 | 72 | 0.60 | 224 | 938,468 |
| McDowell | 660 | 6 | 3.11 | 281 | 497 | 1.77 | 232 | 140 | 1.45 | 242 | 17 | 0.67 | 242 | 290,440 |
| Marion | 270 | 5 | 1.80 | 224 | 225 | 1.64 | 234 | 35 | 1.13 | 238 | 5 | 0.96 | 166 | 113,820 |
| Mason | 303 | 12 | 1.76 | 255 | 246 | 1.58 | 222 | 39 | 1.33 | 260 | 6 | 0.68 | 254 | 123,298 |
| Mercer | 959 | 11 | 3.02 | 308 | 745 | 1.94 | 204 | 173 | 1.67 | 207 | 30 | 0.57 | 210 | 401,321 |
| Mineral | 531 | 7 | 2.34 | 253 | 479 | 1.97 | 224 | 45 | 1.57 | 243 | ........ | ........ | ........ | 259,145 |
| Ohio | 181 | 3 | 1.97 | 235 | 124 | 2.14 | 231 | 51 | 1.45 | 219 | 3 | 0.42 | 280 | 86,136 |
| Preston | 195 | 5 | 2.17 | 265 | 116 | 1.78 | 218 | 71 | 1.29 | 227 | 3 | 0.55 | 208 | 81,411 |
| Putnam | 342 | 5 | 2.90 | 232 | 265 | 1.96 | 205 | 57 | 1.59 | 237 | 15 | 0.65 | 207 | 163,582 |
| Other counties (*a*) | 424 | 10 | 2.36 | 275 | 372 | 1.82 | 237 | 34 | 1.40 | 220 | 8 | 0.56 | 200 | 199,754 |

[a] The counties here grouped, in order that the business of individual establishments may not be disclosed to the public, are Brooke, Marshall, Monongalia, Taylor, and Tucker.

## WYOMING.

The principal coal-mining operations in Wyoming, as reported to the Eleventh Census, are in Uinta, Converse, Sweetwater, Carbon, and Crook counties. The last-named county, however, yielded but a small product, as the extensive developments of the Sundance Coal Syndicate, near New Castle, which is reached by an extension of the Burlington and Missouri River railroad, were not completed in 1889. Mining operations for local trade were also carried on in Johnson and Sheridan counties. The most extensive mining is conducted by the Union Pacific Railway Company at points in Uinta, Sweetwater, and Carbon counties upon the line of the railroad of that company, the lands, of course, lying within the limits of the Union Pacific land grant. Some excellent coal beds are being developed in Converse county, along the line of the Fremont, Elkhorn and Missouri Valley railroad.

Dr. L. D. Ricketts, territorial geologist, states:

> The demand for cheap fuel in this region is constantly increasing, and has finally become so imperative that its supply will warrant a large outlay of capital. With the extension of the railroads of the northwest from the east and the consequent settlement of the country, fuel was brought from the eastern lines with which the lines connected. It is only now that they have advanced so far westward that the opening of new and large coal mines has become a matter of necessity.
>
> Although the available and convenient coal fields are not well known and developed, yet the large amount of preliminary exploitation already made has tended to show that coal fit for commercial use will have to be supplied by Wyoming.

Coal, in its broadest sense, is very widespread in Wyoming. It not only occurs in many separate fields, but these fields are usually of very great size. In the aggregate the surface actually underlaid by coal-bearing strata can not fall short of 30,000 square miles, but some of this immense area lies so far beneath the surface that it is beyond the reach of the miner, and of the remainder many thousand square miles are of little economic importance, on account of the inferior quality of the coal, rendering the land more valuable for agricultural (even as grazing) purposes than for the production of coal. There remains, however, large areas of land capable of furnishing a practically inexhaustible quantity of excellent coal, and this not only includes the area controlled by the Union Pacific railroad, but other areas north of its line, which can and will satisfy the demands of the northwest for a cheap fuel.

### THE ALMY MINES.

Coal has been mined in the vicinity of Almy, in the southwest corner of Wyoming, for about 20 years. It occurs in very large seams subdivided by bands of bone coal or slate, which are either left standing or separated from the coal after it is broken and left in the mine. The coal is used almost exclusively as a locomotive fuel, and is not suited to domestic use. Most of it is consumed by the Central Pacific railway, which, as well as the Union Pacific, controls mines in this locality.

### THE ROCK SPRINGS MINES.

The Rock Springs coal fields are extensive, and the coal is of excellent quality. It may be cheaply mined, cheaply carried, and there is a market for it both east and west. It is already sold on the Missouri river and the Pacific coast and in Colorado and Montana, and as yet the mines are in their infancy. The coal department is largely increasing the capacity of its 5 mines. New companies, encouraged by the policy of the railroads, are opening up mines, and the output promises to be quadrupled in a few years.

Rock Springs coal is celebrated as a fuel for domestic, steam making, and furnace purposes. When intensely heated in a closed vessel it will cake, but does not make a marketable coke. It contains more carbon and less ash than any other Wyoming coal at present mined.

### THE CARBON MINES.

The Carbon mines, like those of Rock Springs, are directly upon the line of the Union Pacific railway. The coal land is broken by a series of faults into a number of separate areas, and each conveniently situated area has a mine, either producing or worked out. The Carbon coal was celebrated as a locomotive fuel, capable of making an intense and large amount of heat, and for such use was the best in Wyoming. Now, however, the old mines are practically worked out, and unless new ground is opened up the town will be abandoned in a few years at most. The owners have foreseen the exhaustion of these mines and prepared for it by opening new ones at Dana and at Chimney Springs, on a branch line from Medicine Bow, to take the place of the Carbon mines.

The coal fields outside the railway land grants which are at present being developed are the Tongue River and Powder River fields, in Johnson and Sheridan counties, and the New Castle fields, in Crook county. The Twin Creek region, in Uinta county, and the Seminoe field, in Carbon county, reported no mining during 1889.

CLASSIFICATION OF COAL DISTRICTS IN WYOMING.

| DISTRICTS. | County. | DISTRICTS. | County. |
|---|---|---|---|
| Northern: | | Southern: | |
| Tongue River | Sheridan. | Seminoe | Carbon. |
| Powder River | Johnson. | Carbon | Do. |
| Eastern: | | Separation | Do. |
| New Castle | Crook. | Southwestern: | |
| Sundance | Do. | Rock Spring | Sweetwater. |
| Fetterman | Converse. | Twin Creek | Uinta. |
| Deer Creek | Do. | Almy | Do. |
| Casper | Natrona. | | |
| Sweetwater | Fremont. | | |

The markets for Wyoming coals, outside of that consumed by the railroad lines for locomotive purposes, are east and west along the Union Pacific railway, and in Montana, eastern Colorado, Nebraska, and Kansas. The quality of the coals of Wyoming is generally lignite, although in some localities analyses show such proportions of fixed carbon and volatile combustible matter as to warrant their classification as semibituminous. Dr. Ricketts, in referring to some analyses under his consideration at the time, says:

> Good coal, containing less than 10 per cent of moisture and possessing other desirable qualities, seems to be wanting in some fields, while in others both good and bad coal occur. I know of no field in Wyoming in which there is all good coal. No matter how good a large amount of the coal may be, every field has also its coal of inferior quality.

The total production of coal in Wyoming during the year ended June 30, 1880, as reported to the Tenth Census, was 589,595 short tons, valued at $1,080,451, or $1.83 per ton, at the mines; total employés, 1,009, and amount paid in wages $579,566. The quantity produced during the calendar year 1889, as reported to the Eleventh Census, was 1,388,947 short tons, valued at $1,748,617, or $1.26 per ton, at the mines. The average number of persons employed during the census year was 2,692, and the amount paid in wages $1,553,947.

## COAL PRODUCT OF WYOMING IN 1889, BY COUNTIES.

[Short tons.]

| COUNTIES. | Total product of coal of all grades for 1889. | DISPOSITION OF TOTAL PRODUCT. | | | | Total amount received for coal sold in 1889. | Average price of coal at the mines. |
|---|---|---|---|---|---|---|---|
| | | Loaded at mines for shipment on railroad cars and boats. | Sold to local trade at mines. | Used by employés. | Used for steam at mines. | | |
| Total | 1, 388, 947 | 1, 354, 443 | 7, 330 | 8, 103 | 19, 071 | $1, 748, 617 | $1. 26 |
| Carbon | 199, 276 | 193, 402 | 1, 501 | 1, 073 | 3, 300 | 194, 817 | 0. 98 |
| Converse | 17, 393 | 16, 285 | 553 | 305 | 250 | 30, 955 | 1. 78 |
| Crook | 200 | | 200 | | | 600 | 3. 00 |
| Johnson | 5, 092 | 2, 300 | 2, 742 | 50 | | 13, 257 | 2. 60 |
| Sheridan | 555 | | 510 | 45 | | 840 | 1. 51 |
| Sweetwater | 857, 213 | 843, 668 | | 3, 368 | 10, 177 | 1, 025, 067 | 1. 20 |
| Uinta | 309, 218 | 298, 788 | 1, 824 | 3, 262 | 5, 344 | 483, 081 | 1. 56 |

## LABOR AND WAGES AT WYOMING COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | Total employés about mine. | ABOVE GROUND. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total average number employed. | Foremen or overseers. | | | Mechanics. | | | Laborers. | | | Boys under 16 years. | | |
| | | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Total | 2, 675 | 369 | 10 | $4. 42 | 263 | 37 | $2. 98 | 269 | 321 | $2. 21 | 253 | 1 | $1. 50 | 156 |
| Carbon | 488 | 93 | 3 | 3. 62 | 137 | 4 | 3. 39 | 236 | 86 | 2. 15 | 227 | | | |
| Sweetwater | 1, 441 | 80 | 4 | 3. 84 | 297 | [illegible] | 3. 00 | 268 | 67 | 2. 18 | 277 | 1 | 1. 50 | 156 |
| Converse, Crook, Johnson, and Uinta. | 746 | 196 | 3 | 5. 41 | 342 | 25 | 2. 91 | 274 | 168 | 2. 25 | 256 | | | |

| COUNTIES. | BELOW GROUND. | | | | | | | | | | | | | Total amount of wages paid during 1889. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total average number employed. | Foremen or overseers. | | | Miners. | | | Laborers. | | | Boys under 16 years. | | | |
| | | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | |
| Total | 2, 306 | 14 | $3. 31 | 310 | 1, 593 | $2. 71 | 231 | 680 | $2. 47 | 220 | 19 | $1. 32 | 238 | $1, 537, 107 |
| Carbon | 395 | [illegible] | 3. 17 | 240 | 309 | 2. 98 | 199 | 79 | 2. 49 | 200 | 5 | 1. 00 | 225 | 263, 067 |
| Sweetwater | 1, 361 | 6 | 3. 06 | 354 | 851 | 2. 57 | 247 | 503 | 2. 50 | 218 | 1 | 2. 25 | 120 | 830, 272 |
| Converse, Crook, Johnson, and Uinta. | 550 | 6 | 3. 65 | 290 | 433 | 2. 85 | 223 | 98 | 2. 31 | 247 | 13 | 1. 40 | 252 | 443, 768 |

## EXPENDITURES AT WYOMING COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | OFFICE FORCE. | | | | | | Grand total employés. | Grand total wages. | Total value of supplies and materials of all kinds during 1889. | Total of all other expenditures for the mines or works. | Total mining expenditures. | Amount paid for contract work during 1889. | Grand total of all expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total. | | Males. | | Females. | | | | | | | | |
| | Number. | Amount of wages. | Number. | Amount of wages. | Number. | Amount of wages. | | | | | | | |
| Total | 17 | $16, 840 | 17 | $16, 840 | | | 2, 692 | $1, 553, 947 | $224, 804 | $37, 324 | $1, 816, 075 | $7, 881 | $1, 823, 956 |
| Carbon and Converse. | 4 | 3, 780 | 4 | 3, 780 | | | 558 | 293, 523 | 36, 766 | 3, 837 | 334, 126 | 1, 190 | 335, 316 |
| Crook and Johnson. | | | | | | | 8 | 4, 590 | 940 | 100 | 5, 630 | | 5, 630 |
| Sweetwater and Uinta. | 13 | 13, 060 | 13 | 13, 060 | | | 2, 126 | 1, 255, 834 | 187, 098 | 33, 387 | 1, 476, 319 | 6, 691 | 1, 483, 010 |

VALUE OF AND POWER AT WYOMING COAL MINES IN 1889, BY COUNTIES.

| COUNTIES. | VALUE OF MINES AND IMPROVEMENTS. | | | | | | | | | POWER USED IN MINING. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In land owned. | | In land leased. | | In buildings and fixtures. | In tools, implements, live stock, machinery, and supplies. | Total. | Cash capital not reported in the foregoing items. | Total capital. | Steam boilers. | | Number of cylinders. | Other power. | | |
| | Acres. | Value. | Acres. | Value. | | | | | | Number. | Horse power. | | Machines. | | Number of animals employed. |
| | | | | | | | | | | | | | Number. | Kind. | |
| Total | 13, 360 | $1, 252, 518 | ........ | ........ | $403, 236 | $392, 198 | $2, 047, 952 | $191, 300 | $2, 239, 252 | 69 | 1, 994 | 46 | 7 | ........ | 161 |
| Carbon and Converse. | 1, 840 | 61, 200 | ........ | ........ | 74, 714 | 99, 093 | 235, 007 | 53, 800 | 288, 807 | 34 | 564 | 28 | ........ | ........ | 63 |
| Crook and Johnson | 3, 240 | 38, 065 | ........ | ........ | 950 | 2, 450 | 41, 465 | 500 | 41, 965 | ........ | ........ | ........ | ........ | ........ | 3 |
| Sweetwater and Uinta. | 8, 280 | 1, 153, 253 | ........ | ........ | 327, 572 | 290, 655 | 1, 771, 480 | 137, 000 | 1, 908, 480 | 35 | 1, 430 | 18 | 7 | Legg | 95 |

# PETROLEUM.

# PETROLEUM.

BY JOSEPH D. WEEKS.

The history of the production of crude petroleum in the United States, its geographical and geological distribution, as well as its technology, were so thoroughly presented in the admirable report of Professor S. F. Peckham, made at the Tenth Census, that it has not been deemed necessary to discuss these topics in detail in the present report. They will only be treated of with sufficient fullness to make intelligent the statistics of the production of petroleum at the Eleventh Census..

It may be proper here to acknowledge the great indebtedness to the several volumes of Mineral Resources of the United States, to Stowell's Petroleum Reporter, the American Manufacturer and Iron World, both published at Pittsburg, Pennsylvania, to the writings of the late Dr. Charles A. Ashburner, Mr. John F. Carll, and Professor Edward Orton, and to the reports of the geological surveys of the various states. It is desired also especially to acknowledge indebtedness to the officers of the Standard Oil Company and its associate organizations for the constant assistance rendered in the preparation of this report. This assistance has been freely given, and has been most important. This report would have been lacking in many details which it now includes, and which add greatly to its value, had not this co-operation been given. No organization was more willing and ready to furnish not only the information called for in the schedule but much of the data used in the preparation of the report.

The difficulties of this investigation growing out of the methods of the industry have been very great, and, in connection with certain of the inquiries, well-nigh insurmountable. Much of the work of drilling and operating the wells, of building rigs, tanks, and pipe lines is done by contract; building rigs at so much a foot or a rig; drilling wells at a fixed sum per foot, including furnishing all labor and materials; pumping wells at so much a barrel, sometimes paid in money and in other instances in a percentage of the oil. Tanks and pipe lines are also usually built or laid at a given contract price. It is very readily seen how difficult it will be to arrive at the number of employés, the wages paid, and the value of materials of this contract work; and yet it is evident that, in order to arrive at a correct statement, not only should the work done and materials furnished by the producer and reported by him in his report on labor and wages and materials used be reported, but the contract work should be included, as well as that done by the producer's employés.

The value of this contract work could be ascertained, it would be supposed, from the parties owning the wells, but it can not be so learned. Very many petroleum producers keep no books. Many of them have no permanent address. They drill a well in new territory, "wild cat", as it is called. If oil is found the well and lease are sold and the parties migrate to another section, and there is no record of cost or even of production except what may be found in the pipe-line companies' reports. In many instances a well or a group of wells will change ownership more than once in a year. The records of labor, production, cost, etc., rarely pass with the ownership. The new owner can not even estimate what the production was, much less cost and labor, and the former owner may or may not be accessible. In such cases the only source of information is the pipe-line reports.

These remarks apply especially to the Pennsylvania and New York and the Lima fields. How these and other difficulties have been met will appear in the proper place in the report. All that is claimed for the statistics here published is that they are the best and most accurate tha tcould be obtained, and that they are the most complete ever published.

## HISTORY OF THE PRODUCTION OF CRUDE PETROLEUM IN THE UNITED STATES.

The history of the production of crude petroleum in the United States may be said to have begun with the striking of oil in the Drake well at Titusville in 1859, though petroleum had been known to exist in this country, and especially in what are now the Pennsylvania petroleum regions, from its earliest explorations by the French. The discovery of petroleum at Titusville led not only to the search for oil in the immediate vicinity but all over the United States. There is scarcely a state in the Union in which explorations for petroleum have not been undertaken. The years from 1859 to 1869 were prolific in the formation of companies with capital aggregating hundreds of millions of dollars, some of it representing actual money invested, the most of it an inflated idea as to the possibilities of the discovery of petroleum in the section of the country covered by the operations of the proposed companies. During these years western Pennsylvania was quite thoroughly exploited for oil, as were also West Virginia, eastern Ohio, Kentucky, Tennessee, Alabama, Colorado, and California. In all of these states oil in some quantities was found. The Macksburg field, in Ohio, was discovered as early as 1860, but assumed little importance until 1884. Oil was found in West Virginia probably as early as 1861 or 1862, but not in great quantities until 1865. The Kentucky, Tennessee, and other fields in the states to the southward of these have never assumed much importance, though considerable oil has been found, especially in Kentucky, in the neighborhood of Glasgow and Bowling Green. The first wells sunk in Colorado were in 1862, though it was not until 1883 that the production assumed any importance. Southern California was quite thoroughly exploited early in the sixties, and operations there have been continuous ever since, though it was not until early in the seventies that the production assumed any degree of importance or continuity.

The year 1885 seems to have marked a new era in the history of petroleum. The importance of the Trenton limestone as an oil producer in the United States was first recognized at this time, and this year marks the discovery of the Lima (Ohio) and the Indiana fields. From the Lima field alone was derived more than one-third of all the oil produced in the United States in 1889.

Near the close of the eighties a remarkable development began in southwestern Pennsylvania in a territory which it was supposed had been thoroughly exploited for oil in previous years without any great returns. Some of the very best oil districts in Pennsylvania, producing in proportion to their area a larger amount of oil than any previously discovered districts, are located in southwestern Pennsylvania, in sections in which it was believed that oil in paying quantities would not be found. Writing in September, 1885, before these wonderful discoveries in southwestern Pennsylvania, the late Dr. Ashburner expresses the opinion that the boundaries of the oil regions of Pennsylvania were well established and that there were no reasonable expectations that any new or extensive field would be found. At this time, according to Dr. Ashburner's statement, a small amount of oil had been found in isolated pools to the south and southeast of Beaver county. One of these pools in which small amounts of oil had been found was in the vicinity of Washington, Washington county. This isolated pool of Washington, yielding small quantities of oil in 1885, furnished nearly 4,000,000 of the 21,487,435 barrels of oil produced in Pennsylvania and New York in 1889, its production being exceeded only by the Butler and Clarion and the Bradford districts.

## ORIGIN OF PETROLEUM AND NATURAL GAS.

It hardly falls within the range of this report to discuss at length the various theories which have been advanced as to the origin of both petroleum and natural gas, though a brief statement is necessary to the better understanding of what shall be said regarding the occurrence of these products in the different states. There are two theories advanced for the origin of these members of the paraffin series, one advanced chiefly by chemists and the other by geologists. The chemical theories that have received the widest currency and discussion are those of Berthelot, a distinguished French chemist, and of Dr. Mendeléjeff, of Saint Petersburg. Both of these gentlemen ascribe the origin of petroleum and natural gas to the action of chemical force on inorganic matter. Berthelot's theory assumes the existence of the alkali metals potassium and sodium in the interior of the earth in a free or uncombined state and at high temperatures. If surface water carrying carbonic acid in solution should find access to these metals in these conditions, chemical reactions could easily take place by which certain of the hydrocarbons would be generated. There is no doubt that various compounds of the bituminous series can be formed artificially, but this seems the only proved fact in Berthelot's theory. There is nothing to prove the assumption that the alkali metals exist in the interior of the earth in a free or uncombined state; in other words, that the conditions necessary to produce petroleum exist in the interior of the earth.

The second chemical theory, that of Dr. Mendeléjeff, has received much wider attention. He also assumes that petroleum is never of organic origin, but purely a product of a reaction between inorganic substances. He assumes, and gives plausible reasons to prove, that petroleum and natural gas have been formed at points much lower than the strata in which they are found and have risen, instead of having been produced at a higher point in the geological scale and descended, basing his views on the well-known facts regarding the cracking, dislocation, and fissuring of the earth's surface and the view of the interior of the earth resulting from the acceptance of Laplace's theory, and still further on Deville's theory of dissociation. He claims that when, in consequence of cooling or some other cause, a fissure takes place through which a mountain range is protruded the crust of the earth is bent and at the foot of the hills fissures are formed or such conditions produced that surface waters are able to make their way deep into the bowels of the earth and to reach occasionally the heated deposits of metallic carbides, which may exist either in a separated condition or blended with other matter. Iron, or whatever metal may be present, forms an oxide with the oxygen of the water. Hydrogen is either set free or combined with the carbon which was associated with the metal and becomes a volatile substance, that is, naphtha. The water which had penetrated down to the incandescent mass is changed into steam; a portion of it finds its way to the porous substance with which the fissures were filled and carries with it the vapors of the newly-formed hydrocarbon, and this mixture of vapors is condensed wholly or in part as soon as it reached the cooler strata. The chemical composition of the hydrocarbons produced will depend upon the conditions of temperature and pressure under which they are formed. Hence it is that mineral oils, mineral pitch, ozocerite, and similar products differ so greatly from each other in the relative proportions of hydrogen and carbon. Artificial petroleum has been frequently prepared by a process analogous to that described. This is Dr. Mendeléjeff's theory. Without discussing it at length, it is sufficient to say that his statements as to the conditions of structure near the surface of the earth which are necessary to his theory do not exist in many of the petroleum districts of this country. As Professor Orton shows, the entire range of the facts of American experience demonstrates the unsoundness of his theory that storage should be provided for in fissures and rents formed in the rock. Possibly an exception to this may be found in the conditions existent in the Colorado field. It may be said here in a general way that Dr. Mendeléjeff's theory has not been accepted by American geologists.

Most of the geologists who have discussed the theory of the origin of petroleum have ascribed it to organic matter incorporated with the stratum when the latter was formed. There is substantial harmony among geologists as to this point. But there is a wide divergence of opinion as to the source of the organic matter and the method by which petroleum and natural gas were formed from it. The majority of geologists incline to the opinion that the chief sources of these hydrocarbons have been vegetable substances, animal remains being also, in the view of some, an important source. Some geologists consider animal remains as the chief source. Many geologists hold that petroleum and natural gas are the results of destructive distillation of organic matter, while others ascribe it to the primary decomposition of organic matter. According to some of the advocates of the destructive distillation theory, petroleum is constantly forming in the rocks, while the views of the others ascribe the time of its formation, as, for example, in the Allegheny fields, to the period when the Appalachian mountains were elevated.

While there are some difficulties in the way of the acceptance of the theory of the primary decomposition of organic matter, it seems to many geologists on the whole to be the best explanation of the facts for which they are obliged to account.

## GEOLOGICAL OCCURRENCE OF PETROLEUM IN THE UNITED STATES.

While petroleum has been found in all the geological formations from the silurian up to the tertiary, it is not uniformly distributed through them, but is found principally in the rocks of the silurian and devonian ages and to a less extent in the mesozoic and tertiary. Cases are known where petroleum has been found in rocks older than the silurian, but it is in small quantities. The great deposits of western Pennsylvania are in the devonian, the Venango, Warren, and McKean groups being of this age, though the place of the Venango group is somewhat open to question, some geologists placing it in the Chemung, others in the Catskill, and some even as high as the Pocono. Considerable oil is produced in Pennsylvania, however, from the carboniferous, the oil on Dunkard creek, in Greene county, being from the Mahoning. Some of the oil sands of Washington, Beaver, and Lawrence counties are from the conglomerate, while the Pocono, or No. X of Rogers, holds the Berea grit, which produces oil and gas in Lawrence and Beaver counties and a large quantity of gas in Butler. The oil, however, found in the carboniferous in Pennsylvania is in small amounts compared with that found in the devonian.

It may be also assumed that the statements regarding the oil horizons of Pennsylvania will apply to the entire oil-producing territory of the western slopes of the Appalachian range.

The oil horizon of western Ohio and Indiana is the Trenton limestone, which is by far the most important single source of petroleum in the United States at the present time. All of the oil produced in the new fields of Ohio and Indiana is from this single horizon, while, as pointed out above, the oil produced in Pennsylvania is from several distinct strata of sandstone of very unequal value, distributed through several thousand feet of the devonian and carboniferous.

The horizon in which the heavy lubricating oils of Kansas and Texas are found has not been determined.

The deposit of petroleum at Florence, in Colorado, is derived from the Larimer shales of the cretaceous formation. By reference to the detailed statement regarding the production of petroleum in Colorado it will be seen that while the drill reaches oil in this shale it is by no means positive that it is even the reservoir. The indications are that it flows into this shale from other rocks.

The oils of California, according to Professor Peckham, are found in the miocene of the tertiary.

## LOCALITIES IN THE UNITED STATES IN WHICH PETROLEUM IS FOUND.

While petroleum has been found in nearly every state and territory, the localities in which it is produced in quantity are but few. These are the well-known oil regions of western Pennsylvania and New York, the Turkey Foot and other districts of West Virginia, the Macksburg and Lima fields in Ohio, the Florence district of Colorado, and the oil fields of southern California. Practically all the petroleum produced in the United States is from the districts named, though a few thousand barrels were produced in Indiana, Kentucky, Illinois, Kansas, and Texas in 1889.

Not only are the localities named above the chief petroleum producing districts in the United States, but the indications are that, with the possible exception of Wyoming, they will continue so to be. The Indiana field has some promise, and may be a producer of some importance in the future. The Kentucky and other southern oil fields, which at one time it was supposed would be factors of some importance in the oil production of the United States, give at the present time no such indication. The Illinois field is an exceedingly small one, with but little promise for the future, while the Kansas and Texas fields will at the best probably produce only a few thousand barrels each year of a high-grade lubricating oil. However, there have been so many surprises in petroleum that these statements must be regarded as only setting forth the present indications.

## CHARACTER AND COMPOSITION OF AMERICAN PETROLEUM.

While the petroleum from different wells in the same district usually differs but little in character, there is a marked variation in many cases in the oils from different districts. The most notable distinction is in the solid constituents of the oil. The "basis" of all the petroleums in the United States, except a portion of those found in the southern part of California, is paraffin; of those of southern California, in most cases, asphalt.

In most of the oils a varying quantity of the lighter hydrocarbons, known in a general way as naphtha, is found. In others these lighter products are almost entirely wanting, or at least in refining all of the distillate is sold as illuminating oil. The composition of certain oils is also such that a large amount of lubricating oil, or heavy oils adapted to lubricating, is produced. For example, the Kansas and Texas oils are natural lubricating oils and can be used without any preparation except straining to remove any grit, while other so-called natural lubricating oils have to be prepared by a process of distillation, the various grades of density being used for various kinds of lubrication.

It may be said in a general way that the products of petroleum are: naphthas, or the lighter hydrocarbons; illuminating oils; heavy oils, or lubricants; residuum, paraffin or asphalt, and water.

Regarding the oils of western Pennsylvania, New York, West Virginia, and the Macksburg district of Ohio, which are chiefly used for the production of illuminating oil, it may be said that the petroleums of these districts as they come from the ground are clear, semitransparent oils, generally of an amber color, but varying somewhat in this regard with their density. When allowed to stand, however, a thick emulsion, reported in the tables of stocks as "B. S.", or sediment, separates itself from the oil. The amount of this sediment varies greatly, the longer the oil is allowed to stand the greater being the proportion of "B. S.", and the less the proportion of the lighter hydrocarbons. It is for this reason that fresh oil, or oil just produced, commanded a premium in 1889 over old oil or that which had been allowed to stand in the tanks, its yield of the lighter hydrocarbons and of the better grades of illuminating oil being greater when fresh than after having been stored.

The percentages of the products of fresh oil in refining will depend largely upon the methods of refining. This can be carried on so as to make the product of heavy oils almost nothing. From a refinery in western Pennsylvania the following statement as the results of their operations for 2 years has been received:

PERCENTAGE OF PRODUCTS FROM PENNSYLVANIA PETROLEUM.

| PRODUCTS. | Per cent. | Per cent. |
|---|---|---|
| Naphthas | 10.34 | 10.89 |
| Illuminating oils | 75.00 | 78.20 |
| Heavy oils | 2.00 to 6.00 | 2.00 to 4.00 |
| Residuum | 4.05 | 2.86 |
| Water and loss | 5.00 to 8.00 | 5.00 to 8.00 |

But little Lima or, better, Trenton limestone oil produced in western Ohio and eastern central Indiana had been refined in a commercial way prior to 1889. The chief obstacle to this use of the oil was the difficulty of removing the sulphur compounds present in it and the small percentage of illuminating oil which could be produced from the crude. At least 2 refineries succeeded in overcoming the difficulties in the way of the sulphur compounds during 1889, and American Trenton limestone oil became a factor in the market to some extent and promises to be a much more important one in the future. The actual facts, however, as to the yield of different products from this oil have been very difficult to obtain. In a general way it may be said to yield a comparatively large percentage of the lighter products and a small percentage of illuminating oil. In general conversation it is customary to assume a yield of 22 per cent in illuminating oils and 15 per cent of naphtha.

In a recent number of the Journal of the American Chemical Society appears an analysis of Lima petroleum, made in the laboratory, however, which shows a yield as follows:

PRODUCTS FROM LIMA (OHIO) PETROLEUM.

| | PER CENT. |
|---|---|
| Naphtha at 70° B | 16 |
| Burning oil | 68 |
| Paraffin oils | 6 |
| Solid residuum | 10 |
| Total | 100 |

These results are never reached in actual practice. Another sample of Lima petroleum gave the following

| | PER CENT. |
|---|---|
| Distillate at 59° B | 13.75 |
| Distillate at 57° B | 35.11 |
| Distillate at 39° B | 7.93 |
| Distillate at 36.5° B | 13.40 |
| Distillate at 36° B | 18.60 |
| Residuum | 9.65 |
| Water | 0.70 |
| Total | 99.14 |

The foregoing would indicate a production of oils approximately as follows:

| | | PER CENT. |
|---|---|---|
| Naphtha and burning oil | | 56.80 |
| Heavy oils | | 32.00 |
| Residuum | | 9.60 |
| Water | | 0.70 |
| Sulphur, first determination | 0.63 | |
| Sulphur, duplicate | 0.68 | |
| Sulphur, average | | 0.65 |
| Total | | 99.75 |

The petroleum from the Florence oil field in Colorado seems to be lacking in the lighter hydrocarbons or naphthas, or at least in refining it all of the distillate is sold as illuminating oil, the whole product of refining being divided into only two classes, illuminating oil and residuum. It yields in refining from 34 to 44 per cent of this illuminating oil of about 125° fire test. This oil contains no B. S.

As has already been pointed out, most of the oil of southern California differs from that of all other sections of the country in having asphaltum as its base instead of paraffin. The oils from the different fields of this section also differ greatly in their character, some being practically liquid bitumens, yielding a very small amount of illuminating oils on distillation, while others have less asphaltum, producing larger percentages of illuminating oil. Here also the results of distillation are only two, one illuminating oil, of which about 35 per cent is produced from the crude charge, the other residuum, which is sold for fuel.

The approximate classification of the distillates of California oil, as given by Mr. Durand Woodman in the Journal of the American Chemical Society, is as follows:

PRODUCTS FROM CALIFORNIA PETROLEUM.

| | PER CENT. |
|---|---|
| Naphtha under 0.73 specific gravity | 10 + |
| Illuminating oils | 40 ± |
| Lubricating oils | 40 ± |
| Residuum | 10 + |
| Sulphur | 0.18 |
| Water | 0.27 |
| Paraffin | None separable. |

## CENSUS STATISTICS.

### NUMBER OF ESTABLISHMENTS.

In the meaning attached to it in manufacturing there is no such thing as an establishment in the crude petroleum industry. An establishment, as the word is used in manufacturing industries, is the aggregation of buildings, machinery, and appliances devoted to the production of the articles or wares whose manufacture or production is the object of the business carried on in the establishments. The only term in the petroleum industry that corresponds to an establishment in manufactures is a well, so that if the term "establishments" is to be used it must be regarded as the number of wells, which, on December 31, 1889, was 35,163.

### TOTAL PRODUCTION OF CRUDE PETROLEUM IN THE UNITED STATES.

In the following table will be found a statement of the total production of crude petroleum of all grades in the United States in 1889, by states:

PRODUCTION OF PETROLEUM IN THE UNITED STATES IN 1889, BY STATES.

| | BARRELS. (a) |
|---|---|
| Pennsylvania and New York | 21,487,435 |
| Ohio | 12,471,466 |
| West Virginia | 544,113 |
| Colorado | 316,476 |
| California | 303,220 |
| Indiana | 33,375 |
| Kentucky | 5,400 |
| Illinois | 1,460 |
| Kansas | 500 |
| Texas | 48 |
| Missouri | 20 |
| Total | 35,163,513 |

a 42 gallons.

In this table the production of Pennsylvania and New York is united. The Bradford (Pennsylvania) field extends into Cattaraugus county, New York, and is so closely connected with the Allegany county (New York) field as to cause them to be regarded as one in most reports. Of the 21,487,435 barrels reported as being produced in Pennsylvania and New York, 7,158,363 barrels were taken from the Bradford-Allegany district. It will probably be approximately correct to estimate that 26.5 per cent of this was produced in New York, 8.5 per cent being from Cattaraugus county and 18 per cent from Allegany county. This would make the production of New York 1,896,966 barrels, and of the Pennsylvania portion of this district 5,261,397 barrels. The production of Cattaraugus county, New York, assuming this estimate to be correct, was 608,461 barrels, and of Allegany county, New York, 1,288,505 barrels.

In the following table will be found consolidated the statistics of the production of petroleum in the United States from the beginning of operations in these fields, so far as the same could be ascertained:

PRODUCT OF CRUDE PETROLEUM IN THE UNITED STATES FROM 1859 TO 1889. (*a*)

[Barrels of 42 gallons.]

| YEARS. | Total United States. | Pennsylvania and New York. | Ohio. | West Virginia. | Colorado. | California. | Indiana. | Kentucky and Tennessee. | Illinois. | Kansas. | Texas. | Missouri. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 408, 332, 710 | 368, 288, 546 | 30, 512, 542 | 5, 327, 561 | 690, 383 | 3, 283, 262 | 33, 375 | 195, 013 | 1, 460 | 500 | 48 | 20 |
| 1859 | 2, 000 | 2, 000 | | | | | | | | | | |
| 1860 | 500, 000 | 500, 000 | | | | | | | | | | |
| 1861 | 2, 113, 609 | 2, 113. 609 | | | | | | | | | | |
| 1862 | *b*3, 056, 690 | 3, 056, 690 | | | | | | | | | | |
| 1863 | 2, 611, 309 | 2, 611, 309 | | | | | | | | | | |
| 1864 | 2, 116, 109 | 2, 116, 109 | | | | | | | | | | |
| 1865 | 2, 497, 700 | 2, 497, 700 | | | | | | | | | | |
| 1866 | 3, 597, 700 | 3, 597, 700 | | | | | | | | | | |
| 1867 | 3, 347, 300 | 3, 347, 300 | | | | | | | | | | |
| 1868 | 3, 646, 117 | 3, 646, 117 | | | | | | | | | | |
| 1869 | 4, 215, 000 | 4, 215, 000 | | | | | | | | | | |
| 1870 | 5, 260, 745 | 5, 260, 745 | | | | | | | | | | |
| 1871 | 5, 205, 234 | 5, 205, 234 | | | | | | | | | | |
| 1872 | 6, 293, 194 | 6, 293, 194 | | | | | | | | | | |
| 1873 | 9, 893, 786 | 9, 893, 786 | | | | | | | | | | |
| 1874 | 10, 926, 945 | 10, 926, 945 | | | | | | | | | | |
| 1875 | *c*12, 162, 514 | 8, 787, 514 | *d*200, 000 | *d*3, 000, 000 | | *d*175, 000 | | | | | | |
| 1876 | 9, 132, 669 | 8, 968, 906 | 31, 763 | 120, 000 | | 12, 000 | | | | | | |
| 1877 | 13, 350, 363 | 13, 135, 475 | 29, 888 | 172, 000 | | 13, 000 | | | | | | |
| 1878 | 15, 396, 868 | 15, 163, 462 | 38, 179 | 180, 000 | | 15, 227 | | | | | | |
| 1879 | 19, 914, 146 | 19, 685, 176 | 29, 112 | 180, 000 | | 19, 858 | | | | | | |
| 1880 | 26, 286, 123 | 26, 027, 631 | 38, 940 | 179, 000 | | 40, 552 | | | | | | |
| 1881 | 27, 661, 238 | 27, 376, 509 | 33, 867 | 151, 000 | | 99, 862 | | | | | | |
| 1882 | *e*30, 510, 830 | 30, 053, 500 | 39, 761 | 128, 000 | | 128, 636 | | *e*160, 933 | | | | |
| 1883 | 23, 449, 633 | 23, 128, 389 | 47, 632 | 126, 000 | | 142, 857 | | 4, 755 | | | | |
| 1884 | 24, 218, 438 | 23, 772, 209 | 90, 081 | 90, 000 | | 262, 000 | | 4, 148 | | | | |
| 1885 | 21, 847, 205 | 20, 776, 041 | 650, 000 | 91, 000 | | 325, 000 | | 5, 164 | | | | |
| 1886 | 28, 064, 841 | 25, 798, 000 | 1, 782, 970 | 102, 000 | | 377, 145 | | 4, 726 | | | | |
| 1887 | 28, 278, 866 | 22, 356, 193 | 5, 018, 015 | 145, 000 | 76, 295 | 678, 572 | | 4, 791 | | | | |
| 1888 | 27, 612, 025 | 16, 488, 668 | 10, 010, 868 | 119, 448 | 297, 612 | 690, 333 | | 5, 096 | | | | |
| 1889 | 35, 163, 513 | 21, 487, 435 | 12, 471, 466 | 544, 113 | 316, 476 | 303, 220 | 33, 375 | 5, 400 | 1, 460 | 500 | 48 | 20 |

*a* Some oil was produced in other states, but no record has been secured other than that contained in note *b*.

*b* In addition to this amount, it is estimated that for want of a market some 10,000,000 barrels ran to waste in and prior to 1862 from the Pennsylvania fields; also a large amount from West Virginia and Tennessee.

*c* Including all production prior to 1876 in Ohio, West Virginia, and California.

*d* Includes all production prior to 1876.

*e* This includes all the petroleum produced in Kentucky and Tennessee prior to 1883.

## PRODUCTION AND VALUE OF CRUDE PETROLEUM IN THE UNITED STATES IN 1889 ACCORDING TO USES.

In the following table are shown by states the production, total value, and value per barrel of the petroleum produced in the United States in 1889 according to uses:

PRODUCTION, VALUE, ETC., OF CRUDE PETROLEUM IN 1889, BY STATES.

| STATES. | TOTAL. | | | ILLUMINATING. | | | LUBRICATING. | | | FUEL. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Production. (Barrels.) | Value. | Average per barrel. | Production. (Barrels.) | Value. | Average per barrel. | Production. (Barrels.) | Value. | Average per barrel. | Production. (Barrels.) | Value. | Average per barrel. |
| Total | 35, 163, 513 | $26, 963, 340 | $0. 76⅝ | 22, 649, 847 | $24, 569, 190 | $1. 08½ | 121, 146 | $325, 927 | $2. 69 | 12, 392, 520 | $2, 068, 223 | $0. 16¾ |
| Pennsylvania and New York. | 21, 487, 435 | 23, 475, 163 | 1. 09¼ | 21, 393, 159 | 23, 225, 453 | 1. 08⅝ | 94, 276 | 249, 710 | 2. 64⅞ | | | |
| Ohio | 12, 471, 466 | 2, 173, 995 | 0. 17⅜ | 317, 037 | 340, 683 | 1. 07½ | 1, 240 | 10, 334 | 8. 33⅜ | 12, 153, 189 | 1, 822, 978 | 0. 15 |
| West Virginia | 544, 113 | 653, 827 | 1. 20⅛ | 520, 511 | 595, 730 | 1. 14½ | 23, 602 | 58, 097 | 2. 46⅛ | | | |
| Colorado | 316, 476 | 280, 240 | 0. 88½ | 316, 476 | 280, 240 | 0. 88½ | | | | | | |
| California | 303, 220 | 256, 048 | 1. 17⅜ | 97, 264 | 121, 684 | 1. 25⅛ | | | | 205, 956 | 234, 364 | 1. 13¾ |
| Indiana | 33, 375 | 10, 881 | 0. 32⅝ | | | | | | | 33, 375 | 10, 881 | 0. 32⅝ |
| Kentucky | 5, 400 | 5, 400 | 1. 00 | 5, 400 | 5, 400 | 1. 00 | | | | | | |
| Illinois | 1, 460 | 4, 906 | 3. 36 | | | | 1, 460 | 4, 906 | 3. 36 | | | |
| Kansas | 500 | 2, 500 | 5. 00 | | | | 500 | 2, 500 | 5. 00 | | | |
| Texas | 48 | 340 | 7. 08⅜ | | | | 48 | 340 | 7. 08⅜ | | | |
| Missouri | 20 | 40 | 2. 00 | | | | 20 | 40 | 2. 00 | | | |

It should be said, in explanation of the preceding table, that the classification is according to uses for which the oil was intended. That classified as illuminating oil includes that production usually sold and delivered to refineries for making into illuminating oil, but in connection with this manufacture there is a certain amount of lighter products, such as benzine, as well as, when it is so desired, a certain amount of lubricating oil, and also of residuum, which may be used as fuel. Under the head of "Fuel" is included the production from those districts the oil of which is used chiefly for fuel purposes, though a small portion of this oil was used in 1889 for the manufacture of illuminating oil, and much larger amounts since. Under the head of "Lubricating" is included only what are known as the natural lubricating oils, which are used only as lubricators, either without any preparation or with slight refining. From this table it will be noticed that the total production of what is classed as illuminating oil in the United States in 1889 was 22,649,847 barrels, valued at $24,569,190, an average value of $1.08½ per barrel. The product of lubricating oil was 121,146 barrels, valued at $325,927, or $2.69 per barrel. The production of what is classed as fuel oil was 12,392,520 barrels, valued at $2,068,223, or 16¾ cents per barrel. With the exception of 205,956 barrels produced in California, all of the fuel oils, so called, produced in the United States were from the Trenton limestone oil fields of Ohio and Indiana. The total production of all grades of oil in the United States was 35,163,513 barrels, valued at $26,963,340, or 76⅝ cents per barrel.

## STOCKS OF CRUDE PETROLEUM.

The stocks of crude petroleum held in tanks at the wells in the United States on December 31, 1888 and 1889, as well as the total production for December, 1888, and December, 1889, are given in the following table. In the states other than Pennsylvania, Ohio, and West Virginia these stocks at the wells represent all the stocks of crude petroleum held by producers or for them. In Pennsylvania, Ohio, and West Virginia to these stocks at the wells should be added the stocks held by the pipe-line companies. Even this total will not represent the amount of crude petroleum in the country, but only that held by the producer or the party who has purchased the oil from him which is still carried in the tanks of the pipe-line companies. The crude petroleum held by the refiners is not included in the statement.

The table of stocks on hand December 31, 1888 and 1889, is as follows:

PRODUCTION AND WELL STOCKS OF CRUDE PETROLEUM IN 1888 AND 1889, BY STATES.

| STATES. | 1888. | | | 1889. | | |
|---|---|---|---|---|---|---|
| | Production, December. (Barrels.) | Stock on hand at wells December 31. (Barrels.) | Per cent of stock at wells, production. | Production, December. (Barrels.) | Stock on hand at wells December 31. (Barrels.) | Per cent of stock at wells, production. |
| Total | 2,727,154 | 447,370 | 16.40 | 3,171,893 | 967,268 | 30.49 |
| Pennsylvania and New York | 1,582,741 | 339,187 | 21.43 | 2,055,247 | 423,336 | 20.60 |
| Ohio | 1,070,746 | 81,224 | 7.59 | 971,538 | 470,125 | 48.39 |
| West Virginia | 19,060 | 6,104 | 32.03 | 81,453 | 6,835 | 8.39 |
| Colorado | 25,769 | 13,092 | 50.81 | 34.570 | 51,034 | 147.63 |
| California | 28,671 | 7,547 | 26.32 | 25,737 | 3,440 | 13.37 |
| Indiana | ........ | ........ | ........ | [a]2,730 | 12,250 | 448.72 |
| Kentucky | ........ | ........ | ........ | [a]450 | ........ | ........ |
| Illinois | [a]120 | 110 | 91.67 | [a]120 | 100 | 83.33 |
| Kansas | [a]42 | 100 | 238.10 | [a]42 | 100 | 238.10 |
| Texas | [a]4 | 6 | 150.00 | [a]4 | 48 | 1,200.00 |
| Missouri | [a]1 | ........ | ........ | [a]2 | ........ | ........ |

[a] Average per month for the year.

From this table it appears that out of a total production in the United States of 2,727,154 barrels in December, 1888, 447,370 barrels, or 16.40 per cent, were carried in stock at the wells on December 31, 1888, while of a production of 3,171,893 barrels in December, 1889, 967,268 barrels, or 30.49 per cent, were carried in stock at the wells. It will be noted that at the close of December, 1888, stocks carried at the wells of Pennsylvania were 21.43 per cent of the total production, and at the close of December, 1889, 423,336 barrels, or 20.60 per cent were carried in stock at the wells. In Ohio but 7.59 per cent of the production of December, 1888, was carried at the wells at the close of that month, while 48.39 per cent of the production of December, 1889, was so carried. The other figures are of but little importance.

The stock of crude petroleum carried by the pipe lines in Pennsylvania and New York at the close of December, 1888, was 18,995,814 barrels. On December 31, 1889, this had decreased to 11,562,593 barrels. The stocks held by the pipe lines in Ohio at the close of December, 1888, were 10,161,842 barrels. At the close of December, 1889, this had increased to 14,415,997 barrels, making a total stock held by the pipe lines at the close of December, 1888, of 29,157,656 barrels, and at the close of December, 1889, of 25,978,590 barrels. Adding these amounts to the stocks carried at the wells, there would be a total of 29,605,026 barrels in stock December 31, 1888, and 26,945,858 barrels on December 31, 1889.

## WELLS.

The number of producing wells in the United States reported at the close of 1888 was 27,841; at the close of 1889, 35,163. Of the 27,841 wells at the close of 1888, 1,621 were flowing wells and 26,220 pumping wells. Of the 35,163 at the close of 1889, 3,209 were flowing and 31,954 pumping wells.

The statements regarding rigs building, wells drilling, number of wells completed, and initial daily production of those completed will be found in the special reports of each state.

The total amount expended for materials used in pumping, operating, and caring for wells is given as $9,505,935. In the following table will be found the number of wells by states:

NUMBER OF PRODUCING PETROLEUM WELLS, BY STATES.

| STATES. | TOTAL. | | FLOWING. | | PUMPING. | |
|---|---|---|---|---|---|---|
| | December 31, 1888. | December 31, 1889. | December 31, 1888. | December 31, 1889. | December 31, 1888. | December 31, 1889. |
| Total | 27, 841 | 35, 163 | 1, 621 | 3, 209 | 26, 220 | 31, 954 |
| Pennsylvania and New York | 25, 420 | 31, 768 | 1, 358 | 2, 398 | 24, 062 | 29, 370 |
| Ohio | 1, 788 | 2, 640 | 255 | 785 | 1, 533 | 1, 855 |
| West Virginia | 505 | 623 | 8 | 23 | 497 | 600 |
| Colorado | 23 | 22 | | | 23 | 22 |
| California | 88 | 89 | | | 88 | 89 |
| Indiana | | 3 | | 3 | | |
| Kentucky | 5 | 6 | | | 5 | 6 |
| Illinois | 5 | 5 | | | 5 | 5 |
| Kansas | 4 | 4 | | | 4 | 4 |
| Texas | 2 | 2 | | | 2 | 2 |
| Missouri | 1 | 1 | | | 1 | 1 |

## CAPITAL.

The total capital invested in the production of crude petroleum in the United States in 1889, including that invested in lands, wells, tanks, pipe lines at wells, and other property, is reported as $114,157,370. Of this, $41,195,525 represented the value of oil lands, while $72,961,845 represented the value of all other property.

The total acreage of oil lands in the United States, both owned and leased, was 1,557,546, of which 356,761 acres were owned and 1,200,785 were leased. Of this land 1,434,019 acres were held in the states of Pennsylvania, New York, Ohio, and West Virginia. The average value of this land per acre is given as $26.45. The average value of the land held in Pennsylvania and New York per acre was $31.13, of that held in Ohio $22.62, and of that held in West Virginia $3.42. It is evident that this is an underestimate. There is no oil land in any of these states that could be bought to-day for anywhere near the largest sum, that is, $31.13. It would be fair to assume not only that the value of the oil land in these states was at least $100 per acre, but to name this sum as the average value of the oil lands all through the United States would be a conservative estimate. This would make the value of the oil lands in the United States $155,754,600, instead of $41,195,525. At present (time of writing this report) there is a small field of some 2,000 acres in western Pennsylvania that could not be bought for $20,000,000. Large amounts of land, including wells, were sold in Pennsylvania in 1889 and 1890 on the basis of $1,200 to $1,500 per well per barrel of production per day. A well producing 5 barrels a day would be worth $6,000 to $7,500. This price was paid in Pennsylvania north of Allegheny county. From this it will be seen that the estimate of $100 an acre is not an excessive one. This would add to the capital employed $114,559,075, a sum very nearly equal to the total capital reported in the table, making the total capital on this basis $228,716,445.

The total value of wells, including rigs, boilers, engines, tubing, casing, etc., is given at $64,679,991. On the basis of 35,163 wells, this would be an average value of $1,839, which, from what is stated above, is evidently very low. A discussion of the question of this average value of wells is given in connection with the report on Pennsylvania.

The statistics of the total capital invested, with that invested in land, wells, rigs, etc., in the production of crude petroleum in 1889 in the United States, are given in the following table by states:

STATISTICS OF THE TOTAL CAPITAL AND THE CAPITAL INVESTED IN PETROLEUM LAND, WELLS, RIGS, ETC.

| STATES. | Total capital. | LAND. | | | | |
|---|---|---|---|---|---|---|
| | | Owned (acres). | Leased (acres). | Total (acres). | Value of land, both owned and leased. | Average value per acre. |
| Total | $114, 157, 370 | 356, 761 | 1, 200, 785 | 1, 557, 546 | $41, 195, 525 | $26. 45 |
| **Pennsylvania and New York** | 89, 562, 008 | 288, 510 | 584, 889 | 873, 399 | 27, 184, 857 | 31. 13 |
| **Ohio** | 17, 771, 152 | 23, 513 | 416, 888 | 440, 401 | 9, 963, 302 | 22. 62 |
| **West Virginia** | *a*1, 472, 598 | 396 | 119, 823 | 120, 219 | 411, 663 | 3. 42 |
| **Colorado** | 3, 000, 000 | 33, 015 | 6, 100 | 39, 115 | 2, 517, 215 | 64. 35 |
| **California** | 2, 186, 958 | 10, 607 | ... | 10, 607 | 1, 060, 000 | 99. 93 |
| **Indiana** | 49, 918 | ... | 12, 585 | 12, 585 | 5, 528 | 0. 44 |
| **Kentucky** | 25, 000 | 100 | 51, 500 | 51, 600 | 10, 150 | 0. 20 |
| **Illinois** | 12, 336 | 20 | 5, 000 | 5, 020 | 2, 600 | 0. 52 |
| **Kansas** | 75, 000 | ... | 4, 000 | 4, 000 | 40, 000 | 10. 00 |
| **Texas** | 1, 650 | ... | ... | ... | ... | ... |
| **Missouri** | 750 | 600 | ... | 600 | 210 | 0. 35 |

| STATES. | WELLS, RIGS, TANKS, PIPE LINES, ETC. | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Total. | Value of rigs, wells, engines, boilers, etc. | Value of tanks. | Value of tank cars. | Pipe lines. | Oil in stock December 31, 1889. | Value of other property. | Average value of wells. |
| Total | $72, 961, 845 | $64, 679, 991 | $1, 825, 356 | $63, 188 | $1, 471, 115 | $594, 636 | $4, 327, 559 | $1, 839 |
| **Pennsylvania and New York** | 62, 377, 151 | 55, 936, 194 | 1, 327, 614 | 7, 255 | 1, 268, 928 | 446, 305 | 3, 390, 855 | 1, 761 |
| **Ohio** | 7, 807, 850 | 6, 627, 835 | 373, 052 | ... | 123, 762 | 76, 063 | 607, 138 | 2, 511 |
| **West Virginia** | 1, 060, 935 | 985, 769 | 35, 904 | ... | 3, 775 | 17, 713 | 17, 774 | 1, 582 |
| **Colorado** | 482, 785 | 229, 659 | 63, 581 | 8, 333 | 7, 903 | 45, 268 | 128, 041 | 10, 439 |
| **California** | 1, 126, 958 | 840, 164 | 11, 250 | 40, 000 | 61, 257 | 4, 036 | 170, 251 | 9, 440 |
| **Indiana** | 44, 390 | 15, 650 | 10, 335 | 5, 800 | 2, 130 | 4, 075 | 6, 400 | 5, 217 |
| **Kentucky** | 14, 850 | 9, 000 | 750 | 1, 800 | 200 | ... | 3, 100 | 1, 500 |
| **Illinois** | 9, 736 | 9, 000 | 250 | ... | 150 | 336 | ... | 1, 800 |
| **Kansas** | 35, 000 | 25, 000 | 2, 500 | ... | 3, 000 | 500 | 4, 000 | 6, 250 |
| **Texas** | 1, 650 | 1, 200 | 100 | ... | 10 | 340 | ... | 600 |
| **Missouri** | 540 | 520 | 20 | ... | ... | ... | ... | 520 |

*a* To this should be added $10,243 capital represented by the cost of leases of 17,630 acres of land on which no developments have been made.

## LABOR AND WAGES.

The total number of persons reported as employed in the production of crude petroleum in the United States in 1889 was 22,539, to whom $8,546,900 were paid in wages. This by no means, however, indicates the total number of persons so employed. A great deal of the work in drilling, torpedoing, and operating wells is done by contract. The books of the producers only show, if they contain any information on this point, the total amount paid for this contract work, which includes not only labor but materials and the profit to the contractor as well, without any of their details. The persons so employed under contract go from place to place through the different oil regions, spending a month or 6 weeks at one place drilling a well, a month at another, a few days deepening a well here, and then a few days somewhere else. In torpedoing wells a similar condition of affairs exists, the time required to torpedo it being very short and the workmen going from well to well and town to town in the oil regions. No estimate of the persons employed in this way has been procured. So also in building tankage and pipe lines. These are usually built by contract, and no labor is paid directly by the petroleum producer. These figures of labor and wages must therefore be understood as including only that labor directly employed and paid by the producers. In order to arrive at the number of persons employed and the wages paid in producing crude petroleum, there must be added to these figures the number of persons employed and the wages paid by contractors in drilling, operating, and caring for wells and in building tankage and pipe lines.

Of the $8,546,900 paid labor by the petroleum producers $534,860 was paid for labor in building rigs, $3,067,886 in drilling wells, $4,505,564 in operating, pumping, and caring for wells, $109,384 in torpedoing wells, $121,318 in building or repairing tankage, $44,732 in building and repairing pipe lines at the wells, and $163,156 to the office force. The amount of money paid in the office does not include what would be termed executive officers of the different companies, but probably only clerks, bookkeepers, and similar persons. At a great many wells there is no office force at all, the proprietor of a well, who may be engaged in other business, letting the contract for pumping his oil to certain parties and paying but little attention himself to the well, and receiving only the pipe line transportation company's statement as to the amount of oil due him.

Concerning the different rates of wages paid foremen, pumpers or engineers, and drillers, shown in the various tables of classified wages that will appear through this report, it should be noted that a pumper or engineer may operate a number of wells and the lowest rate given may be for one well and the highest rate for a group of wells. A similar remark will apply to the wages of foremen.

The statistics of labor and wages in the production of crude petroleum in the United States in 1889, by states, are as follows:

### TOTAL NUMBER OF EMPLOYÉS AND NUMBER OF EACH CLASS AND WAGES PAID.

| STATES. | Number of employés. | Total wages. | Number of foremen. | Wages paid to foremen. | Number of mechanics. | Wages paid to mechanics. | Number of laborers. | Wages paid to laborers. | Number of boys under 16. | Wages paid to boys. | OFFICE FORCE. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Number of males. | Wages. | Number of females. | Wages. |
| Total | 22, 539 | $8, 546, 900 | 1, 354 | $846, 205 | 11, 084 | $4, 125, 991 | 9, 772 | $3, 358, 355 | 156 | $53, 193 | 166 | $161, 852 | 7 | $1, 304 |
| Pennsylvania and New York. | 19, 832 | 7, 423, 781 | 1, 230 | 744, 674 | 10, 049 | 3, 742, 416 | 8, 256 | 2, 748, 453 | 156 | 53, 193 | 134 | 133, 741 | 7 | 1, 304 |
| Ohio | 2, 123 | 836, 377 | 94 | 71, 613 | 724 | 235, 607 | 1, 282 | 509, 421 | | | 23 | 19, 736 | | |
| West Virginia | 339 | 160, 974 | 17 | 14, 520 | 213 | 108, 298 | 107 | 36, 756 | | | 2 | 1, 400 | | |
| Colorado | 90 | 34, 632 | 5 | 4, 950 | 56 | 19, 138 | 28 | 8, 744 | | | 1 | 1, 800 | | |
| California | 95 | 75, 056 | 5 | 8, 000 | 25 | 18, 147 | 62 | 46, 284 | | | 3 | 2, 625 | | |
| Indiana | 34 | 6, 080 | 1 | 1, 200 | 7 | 725 | 25 | 4, 105 | | | 1 | 50 | | |
| Kentucky | 14 | 3, 050 | 2 | 1, 248 | 8 | 660 | 4 | 1, 142 | | | | | | |
| Illinois | 1 | 600 | | | | | 1 | 600 | | | | | | |
| Kansas | 10 | 6, 000 | | | 2 | 1, 000 | 6 | 2, 500 | | | 2 | 2, 500 | | |
| Missouri | 1 | 350 | | | | | 1 | 350 | | | | | | |

### TOTAL WAGES PAID AND WAGES PAID FOR THE SEVERAL CLASSES OF WORK.

| STATES. | Total. | WAGES PAID IN— | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Building rigs. | Drilling wells. | Operating and caring for wells. | Torpedoing wells. | Building and repairing tankage. | Building and repairing pipe lines. | Office. |
| Total | $8, 546, 900 | $534, 860 | $3, 067, 886 | $4, 505, 564 | $109, 384 | $121, 318 | $44, 732 | $163, 156 |
| Pennsylvania and New York. | 7, 423, 781 | 4   214 | 2, 780, 795 | 3, 773, 139 | 105, 626 | 110, 268 | 40, 694 | 135, 045 |
| Ohio | 836, 377 | 30, 254 | 174, 299 | 595, 518 | 3, 728 | 9, 440 | 3, 402 | 19, 736 |
| West Virginia | 160, 974 | 19, 869 | 82, 312 | 55, 903 | 30 | 1, 460 | | 1, 400 |
| Colorado | 34, 632 | 2, 703 | 8, 099 | 21, 494 | | | 536 | 1, 800 |
| California | 75, 056 | 3, 195 | 20, 131 | 49, 055 | | 50 | | 2, 625 |
| Indiana | 6, 080 | 125 | 600 | 5, 305 | | | | 50 |
| Kentucky | 3, 050 | 200 | 1, 650 | 1, 200 | | | | |
| Illinois | 600 | | | 600 | | | | |
| Kansas | 6, 000 | 300 | | 3, 000 | | 100 | 100 | 2, 500 |
| Missouri | 350 | | | 350 | | | | |

## STATISTICS OF THE PRODUCTION OF CRUDE PETROLEUM IN 1889.

The condensed statistics of the production of crude petroleum, stocks, number of wells, capital and labor employed, and wages paid in the United States in 1889 are as follows:

### PRODUCTION OF OIL IN 1889.

| | BARRELS. |
|---|---|
| Illuminating | 22, 649, 847 |
| Lubricating | 121, 146 |
| Fuel | 12, 392, 520 |
| Total | 35, 163, 513 |

### VALUE AT WELLS OF ALL OIL PRODUCED, EXCLUDING PIPAGE.

| KINDS OF OIL. | Total value. | Value per barrel. |
|---|---|---|
| Total | $26, 963, 340 | $0. 76⅝ |
| Illuminating | 24, 569, 190 | 1. 08½ |
| Lubricating | 325, 927 | 2. 69 |
| Fuel | 2, 068, 223 | 0. 16¾ |

## STOCKS OF ALL GRADES ON HAND AT WELLS.

| | BARRELS. |
|---|---|
| December 31, 1888 | 447, 370 |
| December 31, 1889 | 967, 268 |

## WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 27, 841 |
| Total number of producing wells December 31, 1889 | 35, 163 |
| Total number of flowing wells December 31, 1888 | 1, 621 |
| Total number of flowing wells December 31, 1889 | 3, 209 |
| Total number of pumping wells December 31, 1888 | 26, 220 |
| Total number of pumping wells December 31, 1889 | 31, 954 |
| Number of wells completed in 1889 | 6, 496 |
| Number of dry holes in 1889 | 995 |
| Number of producing wells completed in 1889 | 5, 501 |
| Initial daily production of new wells (barrels) | 136, 322 |
| Number of rigs building December 31, 1888 | 216 |
| Number of rigs building December 31, 1889 | 500 |
| Number of wells drilling December 31, 1888 | 323 |
| Number of wells drilling December 31, 1889 | 681 |
| Value of materials used in caring for and operating wells in 1889 | $9, 505, 935 |

## CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in business | | $114, 157, 370 |
| Number of acres of oil land: | | |
| Owned | 356, 761 | |
| Leased | 1, 200, 785 | |
| Total acreage | 1, 557, 546 | |
| Present value of land, both owned and leased | | 41, 195, 525 |
| Average value per acre, $26.45. | | |
| Value of rigs, wells, engines, boilers, etc | | $64, 679, 991 |
| Average value of wells, $1,839. | | |
| Value of tanks | | 1, 825, 356 |
| Value of tank cars | | 63, 188 |
| Value of pipe lines at wells owned by parties making report | | 1, 471, 115 |
| Value of oil in stock at wells December 31, 1889 | | 594, 636 |
| Value of other property and improvements | | 4, 327, 559 |
| Total | | 72, 961, 845 |

## LABOR AND WAGES.

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of foremen or overseers | 1, 354 | |
| Total wages paid all workmen of this class in 1889 | | $846, 205 |
| Number of mechanics | 11, 084 | |
| Total wages paid all workmen of this class in 1889 | | 4, 125, 991 |
| Number of laborers | 9, 772 | |
| Total wages paid all workmen of this class in 1889 | | 3, 358, 355 |
| Boys under 16 years | 156 | |
| Total wages paid all boys under 16 years | | 53, 193 |
| Office force: | | |
| Total number of males | 166 | |
| Total number of females | 7 | |
| Total wages paid males | | 161, 852 |
| Total wages paid females | | 1, 304 |
| Total number of persons employed and wages paid in 1889 | 22, 539 | 8, 546, 900 |

| | |
|---|---|
| Wages paid for labor: | |
| In building rigs | $534, 860 |
| In drilling wells | 3, 067, 886 |
| In operating and caring for wells | 4, 505, 564 |
| In torpedoing wells | 109, 384 |
| In building or repairing tankage | 121, 318 |
| In building and repairing pipe lines at wells | 44, 732 |
| In office | 163, 156 |
| Total | 8, 546, 900 |

## PENNSYLVANIA.

Owing to their intimate connection in a commercial way, it is almost impossible to make an exact separation between the oil produced in New York and Pennsylvania. The basis for all information regarding the production of oil in Pennsylvania and New York is the pipe-line reports, and in these reports of the Bradford district no distinction is made between the oil produced in Pennsylvania and that in New York, the Bradford district including portions of McKean county, Pennsylvania, and Cattaraugus county, New York. The returns for the northern field, as it is called, includes not only the Bradford district, and, consequently, the production of the wells in Cattaraugus county, New York, but also of the wells of Allegany county, in the same state. An attempt has been made to separate the oil produced in New York from that in Pennsylvania, but at best the result must be regarded only as an approximation.

In this report Pennsylvania is divided into eleven districts, as follows: (1) the Bradford district, (2) Forest county, (3) Warren county, (4) Butler, Clarion, and Elk counties, etc., (5) Tidioute and Titusville, (6) Allegheny (Pennsylvania) county, (7) Beaver county, (8) Washington county, (9) Greene county, (10) the Franklin lubricating oil district, and (11) Smiths Ferry district. These may be classified in a general way into the Bradford, Middle, Lower, and Washington or Southwestern districts.

The Bradford district lies chiefly in Pennsylvania, in McKean county, but the main field extends some 5 or 6 miles into New York. An outlying basin of oil rock, which properly belongs to the Bradford basin, is situated for the greater part in Carrollton township, Cattaraugus county, New York. This field also includes the small outlying district of Kinzua, which lies southwest from the main district and contains large and long-lived wells, and the Windfall Run field, lying in Pennsylvania near Eldred, which has only small wells. The sand from which the oil in the Allegany (New York) and Bradford districts is obtained is a gray, black, dark brown, or chocolate brown sand of about the coarseness of the ordinary beach sand of the New Jersey coast. The oil obtained is dark amber green, and occasionally black. Its gravity is generally slightly greater than that of the oil usually obtained from the Venango and Butler districts.

The Middle field, the Warren and Forest, is located in the counties from which it takes its name. It includes such pools as Cherry Grove, Balltown and Cooper, Stoneham, Clarendon, Tiona, Kane, Grand Valley, and others in these 2 counties. The oil in this district comes from sands of varying geological horizons, having somewhat the general appearance of the Bradford and Allegany sand, but frequently coarser grained. The late Dr. Ashburner was of the opinion that the Allegany (New York), Bradford, Warren, and Forest district oil sands were of the Chemung (devonian) age. The oils from the several Warren and Forest pools differ very greatly in color and gravity, but they are generally spoken of as amber oils.

The Lower field begins with a few pools in the southwestern corner of Warren and the western end of Forest counties and embraces all the oil-producing territory southward, including the fields of Venango, Clarion, and Butler counties, the field on the Ohio river in Beaver county, and the fields in Lawrence county. The oil of the Venango subdivision of the Lower district is obtained from 3 principal sand beds, known, respectively, as the first, second, and third oil sands, contained within an interval of about 350 feet. These sands are believed to belong to the Catskill (devonian) formation. These sands were the first discovered in Pennsylvania, and drillers from this field operating in other districts designated the sands which were found in the new districts as the first, second, and third sands, irrespective of their geological position. The Venango sands generally consist of white, gray, or yellow pebble rock. The oils vary, though generally they are green in color, sometimes black, and in a few instances amber. The gravity varies from 30° to 51°, 48° being about the average of the oil obtained from the third sand, which is the greatest producer. The Butler subdivision of the Lower district includes oil pools in Butler, Clarion, southeastern Venango, and Armstrong counties. The character of the sands and oils are very much the same as the Venango district. The Beaver subdivision of the Lower district includes chiefly the Slippery Rock and Smiths Ferry fields. In both of these pools heavy oil is obtained from the representative of the Pottsville conglomerate and amber oil from the Berea grit, in the subcarboniferous series.

The Washington or Southwestern district includes the wells in Allegheny, Washington, and Greene counties, in southwestern Pennsylvania. The general character of the sands and oil is similar to that of the Lower district.

### PRODUCTION IN PENNSYLVANIA AND NEW YORK.

In the table on the following page is given the actual production of crude petroleum in the states of Pennsylvania and New York in 1889, by months and districts. The total production is shown by this report to be 21,487,435 barrels. This total differs somewhat from the totals of the pipe-line runs, which are the receipts from the wells by the pipe-lines as published from month to month. These runs, as shown elsewhere, are 21,790,953 barrels, but these runs include all the production of Pennsylvania and New York and a portion of the production of West Virginia. After making due allowance for the West Virginia runs, the totals as given in the table of production and the pipe-line totals do not differ greatly. In fact, so far as it can be ascertained the pipe-line runs in 1889 approximated very closely to the actual production.

The production of crude petroleum in Pennsylvania and New York in 1889, by districts and months, is as follows:

PRODUCTION OF CRUDE PETROLEUM IN PENNSYLVANIA AND NEW YORK IN 1889, BY DISTRICTS AND MONTHS.

[Barrels of 42 gallons.]

| DISTRICTS. | Total. | January. | February. | March. | April. | May. |
|---|---|---|---|---|---|---|
| Pennsylvania and New York | 21,487,435 | 1,542,806 | 1,332,482 | 1,628,661 | 1,635,933 | 1,821,776 |
| Bradford district, Pennsylvania and New York, and Allegany county, New York. | 7,158,363 | 603,946 | 490,878 | 607,804 | 548,903 | 595,371 |
| Forest county | 258,955 | 19,537 | 16,737 | 21,689 | 19,393 | 23,699 |
| Warren county | 2,347,434 | 174,437 | 162,844 | 190,188 | 201,159 | 209,474 |
| Butler and Clarion counties, etc | 5,358,403 | 412,733 | 352,432 | 405,950 | 406,797 | 432,769 |
| Tidioute and Titusville | 885,119 | 66,569 | 61,135 | 70,321 | 67,122 | 83,560 |
| Allegheny county | 541,092 | 20,495 | 22,599 | 28,996 | 32,625 | 50,598 |
| Beaver county | 602,736 | 27,361 | 23,230 | 28,159 | 28,092 | 45,796 |
| Washington county | 3,848,145 | 185,516 | 171,165 | 244,474 | 301,799 | 349,192 |
| Greene county | 392,912 | 24,707 | 23,873 | 22,383 | 21,836 | 23,527 |
| Franklin district | 65,276 | 5,088 | 5,172 | 6,280 | 5,790 | 5,373 |
| Smiths Ferry district (*a*) | 29,000 | 2,417 | 2,417 | 2,417 | 2,417 | 2,417 |

| DISTRICTS. | June. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|
| Pennsylvania and New York | 1,811,485 | 1,954,168 | 1,964,227 | 1,867,610 | 1,959,169 | 1,913,871 | 2,055,247 |
| Bradford district, Pennsylvania and New York, and Allegany county, New York. | 614,286 | 638,763 | 628,792 | 586,686 | 618,286 | 598,952 | 625,696 |
| Forest county | 22,647 | 23,673 | 22,336 | 21,823 | 22,432 | 23,132 | 21,857 |
| Warren county | 202,385 | 211,600 | 201,766 | 191,843 | 206,944 | 195,290 | 199,504 |
| Butler and Clarion counties, etc. | 413,407 | 451,064 | 490,873 | 475,925 | 502,541 | 484,772 | 529,140 |
| Tidioute and Titusville | 72,476 | 77,392 | 75,450 | 68,728 | 78,365 | 80,920 | 83,081 |
| Allegheny county | 55,214 | 56,529 | 54,387 | 49,942 | 59,086 | 49,606 | 61,015 |
| Beaver county | 41,071 | 51,675 | 49,354 | 49,545 | 57,670 | 78,007 | 122,776 |
| Washington county | 357,033 | 401,325 | 397,093 | 376,007 | 363,830 | 351,509 | 349,202 |
| Greene county | 24,792 | 33,819 | 36,767 | 38,768 | 42,719 | 44,176 | 55,545 |
| Franklin district | 5,757 | 5,911 | 4,992 | 5,927 | 4,880 | 5,091 | 5,015 |
| Smiths Ferry district (*a*) | 2,417 | 2,417 | 2,417 | 2,416 | 2,416 | 2,416 | 2,416 |

*a* Smiths Ferry production, which was very regular, is averaged at 2,416.67 barrels per month.

In the following table will be found the production of Pennsylvania and New York for 1888 and 1889, compared by districts:

PRODUCTION OF CRUDE PETROLEUM IN PENNSYLVANIA AND NEW YORK IN 1888 AND 1889, BY DISTRICTS.

[Barrels.]

| DISTRICTS. | 1888. | 1889. |
|---|---|---|
| Total | 16,488,668 | 21,487,435 |
| Bradford-Allegany | 6,284,375 | 7,158,363 |
| Forest county | 204,250 | 258,955 |
| Warren county | 1,865,366 | 2,347,434 |
| Butler, Clarion, Venango, etc., counties (*a*) | 4,698,441 | 5,423,679 |
| Tidioute and Titusville | 660,328 | 885,119 |
| Beaver county | 356,684 | 602,736 |
| Washington and Allegheny counties (*b*) | 2,326,190 | 4,418,237 |
| Greene county | 93,034 | 392,912 |

*a* Including Franklin district. *b* Including Smiths Ferry district.

The notable feature in the above comparison is the great increase in production in 1889 over that of 1888. This is due to two causes. The production of the earlier months of 1888 was very much curtailed, owing to the agreement to reduce production entered into by the members of the Petroleum Producers' Association. The compact was that at least 17,500 barrels of the daily product and as much more as possible should be shut in. This agreement lasted from the 1st of November, 1887, to the 1st of November, 1888. The result was that the production declined from 22,356,193 barrels in 1887 to 16,488,668 in 1888, but with the removal of this restriction it began to increase, and in the older districts the increases in 1889 over 1888 are due mainly to this removal of the restriction. This is especially shown in the Bradford and Allegany districts, the Forest and Warren, Tidioute and Titusville, and to a less extent in the Butler and Clarion districts. It is probable that all of the increased production in 1889 over 1888 in the first 4 named districts is to be ascribed to this removal of the restriction of production. Part of the increase in Butler county is due to an extension of the field.

Nearly all of the increased production in Beaver, Washington, Allegheny, and Greene counties, or in the Southwestern district, is due to what may be called an extension of the field or the discovery of new pools.

Assuming that the production of Smiths Ferry oil was an average of 2,416.67 barrels per month, the production of crude petroleum in Pennsylvania and New York in 1888, as compared with 1889, by months, shows the following:

### PRODUCTION OF CRUDE PETROLEUM IN PENNSYLVANIA AND NEW YORK IN 1888 AND 1889, BY MONTHS.

[Barrels.]

| MONTHS. | 1888. | 1889. |
|---|---|---|
| Total | 16, 488, 668 | 21, 487, 435 |
| January | 1, 155, 937 | 1, 542, 806 |
| February | 1, 290, 718 | 1, 332, 482 |
| March | 1, 338, 877 | 1, 628, 661 |
| April | 1, 349, 403 | 1, 635, 933 |
| May | 1, 473, 362 | 1, 821, 776 |
| June | 1, 450, 703 | 1, 811, 485 |
| July | 1, 394, 847 | 1, 954, 168 |
| August | 1, 382, 077 | 1, 964, 227 |
| September | 1, 273, 080 | 1, 867, 610 |
| October | 1, 354, 518 | 1, 959, 169 |
| November | 1, 442, 405 | 1, 913, 871 |
| December | 1, 582, 741 | 2, 055, 247 |

A similar increase in production by months in 1889, as compared with 1888, is noticeable in this table, as in the table of production by districts, and the causes are the same, namely, the resumption of production after the restriction of 1888 and the opening up of new fields or extensions of those already known.

The total production of crude petroleum in the Pennsylvania and New York oil fields from 1871 to 1889, by months and years, is as follows:

### TOTAL PRODUCT OF CRUDE PETROLEUM IN THE PENNSYLVANIA AND NEW YORK OIL FIELDS FOR THE YEARS 1871–1889, BY MONTHS AND YEARS.

[Barrels.]

| YEARS. | Total. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1871 | 5, 205, 234 | 418, 407 | 372, 568 | 400, 334 | 385, 980 | 408, 797 | 410, 340 | 456, 475 | 462, 582 | 461, 940 | 485, 243 | 464, 610 | 477, 958 |
| 1872 | 6, 293, 194 | 583, 575 | 462, 985 | 461, 590 | 462, 090 | 537, 106 | 491, 130 | 517, 762 | 549, 909 | 500, 430 | 442, 432 | 638, 610 | 645, 575 |
| 1873 | 9, 893, 786 | 632, 617 | 608, 300 | 665, 291 | 641, 520 | 776, 364 | 793, 470 | 867, 473 | 936, 138 | 954, 270 | 942, 493 | 991, 470 | 1, 084, 380 |
| 1874 | 10, 926, 945 | 1, 167, 243 | 835, 492 | 883, 438 | 778, 740 | 895, 745 | 921, 750 | 1, 033, 447 | 931, 519 | 840, 630 | 919, 739 | 861, 060 | 858, 142 |
| 1875 | 8, 787, 514 | 852, 159 | 719, 824 | 789, 539 | 675, 060 | 696, 508 | 696, 210 | 788, 361 | 718, 766 | 698, 940 | 731, 073 | 700, 200 | 720, 874 |
| 1876 | 8, 968, 906 | 712, 225 | 668, 885 | 718, 177 | 701, 490 | 735, 351 | 723, 600 | 763, 623 | 782, 223 | 780, 600 | 809, 162 | 786, 480 | 787, 090 |
| 1877 | 13, 135, 475 | 842, 890 | 783, 216 | 901, 697 | 972, 810 | 1, 127, 594 | 1, 130, 790 | 1, 189, 005 | 1, 273, 759 | 1, 214, 910 | 1, 269, 326 | 1, 173, 420 | 1, 256, 058 |
| 1878 | 15, 163, 462 | 1, 203, 296 | 1, 094, 856 | 1, 208, 380 | 1, 195, 890 | 1, 264, 862 | 1, 217, 250 | 1, 283, 865 | 1, 341, 928 | 1, 315, 710 | 1, 369, 797 | 1, 348, 950 | 1, 318, 678 |
| 1879 | 19, 685, 176 | 1, 369, 921 | 1, 261, 935 | 1, 499, 315 | 1, 530, 450 | 1, 644, 922 | 1, 675, 650 | 1, 637, 767 | 1, 892, 302 | 1, 856, 700 | 1, 836, 378 | 1, 710, 480 | 1, 769, 356 |
| 1880 | 26, 027, 631 | 1, 904. 113 | 1, 870, 008 | 2, 015, 992 | 2, 015, 700 | 2, 228, 931 | 2, 158, 440 | 2, 248, 430 | 2, 341, 027 | 2, 346, 300 | 2, 385, 636 | 2, 274, 420 | 2, 238, 634 |
| 1881 | 27, 376, 509 | 2, 244, 090 | 1, 913, 128 | 2, 274, 532 | 2, 205, 780 | 2, 393, 293 | 2, 377, 860 | 2, 372, 678 | 2, 331, 727 | 2, 193, 420 | 2, 323, 171 | 2, 266, 830 | 2, 480, 000 |
| 1882 | 30, 053, 500 | 2, 353, 551 | 2, 131, 332 | 2, 482, 170 | 2, 402, 790 | 2, 486, 572 | 2, 825, 940 | 3, 258, 162 | 3, 104, 495 | 2, 620, 380 | 2, 297, 658 | 2, 192, 940 | 1, 897, 510 |
| 1883 | 23, 128, 389 | 1, 948, 319 | 1, 756, 188 | 1, 830, 674 | 1, 816, 530 | 1, 962, 052 | 1, 977, 900 | 2, 020, 394 | 1, 879, 437 | 1, 913, 370 | 2, 076, 659 | 1, 958, 340 | 1, 988, 526 |
| 1884 | 23, 772, 209 | 1, 825, 838 | 1, 880, 650 | 2, 052, 262 | 2, 065, 860 | 2, 381, 854 | 1, 862, 190 | 2, 059, 950 | 2, 099, 165 | 1, 948, 260 | 1, 961, 866 | 1, 811, 700 | 1, 822, 614 |
| 1885 | 20, 776, 041 | 1, 652, 176 | 1, 437, 884 | 1, 638, 133 | 1, 780, 290 | 1, 771, 371 | 1, 767, 210 | 1, 775, 804 | 1, 705, 961 | 1, 712, 790 | 1, 874, 105 | 1, 761, 660 | 1, 898, 657 |
| 1886 | 25, 798, 000 | 1, 748, 958 | 1, 604, 848 | 1, 928, 448 | 1, 938, 360 | 2, 178, 773 | 2, 335, 380 | 2, 418, 961 | 2, 413, 206 | 2, 418, 540 | 2, 408, 111 | 2, 222, 790 | 2, 181, 625 |
| 1887 | *a*21, 478, 883 | 1, 990, 851 | 1, 827, 924 | 2, 007, 196 | 1, 960, 860 | 1, 993, 517 | 1, 912, 860 | 1, 899, 525 | 1, 848, 877 | 1, 779, 930 | 1, 843, 291 | 1, 125, 450 | 1, 288, 602 |
| 1888 | 16, 488, 668 | 1, 155, 937 | 1, 290, 718 | 1, 338, 877 | 1, 349, 403 | 1, 473, 362 | 1, 450, 703 | 1, 394, 847 | 1, 382, 077 | 1, 273, 080 | 1, 354, 518 | 1, 442, 405 | 1, 582, 741 |
| 1889 | 21, 487, 435 | 1, 542, 806 | 1, 332, 482 | 1, 628, 661 | 1, 635, 933 | 1, 821, 776 | 1, 811, 485 | 1, 954, 168 | 1, 964, 227 | 1, 867, 610 | 1, 959, 169 | 1, 913, 871 | 2, 055, 247 |

*a* Not including 877,310 barrels dump oil and oil shipped by private lines.

For some years previous to and including 1887 the total production as given is simply the total of the pipe-line runs. The statistics in the early years, as indeed all of the figures up to the close of 1888, are those published in Stowell's Petroleum Reporter.

As the pipe-line runs for 1888 and 1889 differ from the totals of production as given in the above table, and as these runs are of sufficient importance to those interested in the production of petroleum to become a matter of record, the runs of these 2 years are given on the following page.

The runs of the several pipe lines for 1889 as reported from month to month in Pennsylvania and New York and that portion of West Virginia tributary to the southwestern Pennsylvania field are as follows, by months and lines:

PIPE-LINE RUNS IN PENNSYLVANIA AND NEW YORK IN 1889, BY LINES AND MONTHS.

[Barrels.]

| MONTHS. | Total. | National. | Tide water. | Octave. | Miller. | Western Atlantic. | Southwest. | Franklin. |
|---|---|---|---|---|---|---|---|---|
| Total | 21, 790, 953 | 13, 675, 776 | 1, 593, 939 | 32, 536 | 188, 113 | 2, 501, 826 | 3, 734, 519 | 64, 244 |
| January | 1, 513, 012 | 1, 071, 087 | 128, 904 | 1, 847 | 16. 734 | 110, 718 | 178, 720 | 5, 002 |
| February | 1, 307, 652 | 901, 549 | 104, 962 | 2, 034 | 14, 564 | 105, 060 | 174, 397 | 5, 086 |
| March | 1, 608, 755 | 1, 102, 168 | 111, 387 | 2, 179 | 17, 020 | 142, 150 | 227, 657 | 6, 194 |
| April | 1, 629, 203 | 1, 071, 665 | 89, 900 | 2, 079 | 17, 277 | 176, 699 | 265, 879 | 5, 704 |
| May | 1, 794, 129 | 1, 119, 920 | 126, 692 | 2, 908 | 16, 497 | 207, 896 | 314, 929 | 5, 287 |
| June | 1, 804, 671 | 1, 104, 626 | 133, 160 | 2, 421 | 15, 877 | 209, 506 | 333, 410 | 5, 671 |
| July | 1, 945, 668 | 1, 181, 200 | 132, 106 | 2, 719 | 17, 348 | 232, 940 | 373, 530 | 5, 825 |
| August | 1, 961, 426 | 1, 174, 489 | 130, 835 | 3, 186 | 15, 399 | 277, 143 | 355, 468 | 4, 906 |
| September | 1, 860, 140 | 1, 103, 009 | 125, 908 | 3, 863 | 14, 813 | 277, 662 | 329, 044 | 5, 841 |
| October | 1, 968, 513 | 1, 185, 362 | 133, 965 | 3, 318 | 14, 362 | 263, 834 | 362, 878 | 4, 794 |
| November | 1, 898, 626 | 1, 118, 210 | 146, 226 | 2, 668 | 14, 086 | 243, 813 | 368, 618 | 5, 005 |
| December | 2, 499, 158 | 1, 542, 491 | 229, 894 | 3, 314 | 14, 136 | 254, 405 | 449, 989 | 4, 929 |

The total runs by months for 1888 and 1889 are given below. It should be borne in mind, as stated above, that the runs for 1889 include a portion of the production of West Virginia as well as all of the production of Pennsylvania and New York.

PIPE-LINE RUNS IN PENNSYLVANIA AND NEW YORK IN 1888 AND 1889, BY MONTHS.

[Barrels.]

| MONTHS. | 1888. | 1889. |
|---|---|---|
| Total | 16, 022, 792 | 21, 790, 953 |
| January | 1, 126, 035 | 1, 513, 012 |
| February | 1, 240, 092 | 1, 307, 652 |
| March | 1, 211, 086 | 1, 608, 755 |
| April | 1, 320, 936 | 1, 629, 203 |
| May | 1, 433, 469 | 1, 794, 129 |
| June | 1, 422, 960 | 1, 804, 671 |
| July | 1, 370, 080 | 1, 945, 668 |
| August | 1, 365, 992 | 1, 961, 426 |
| September | 1, 253, 149 | 1, 860, 140 |
| October | 1, 311, 643 | 1, 968, 513 |
| November | 1, 416, 448 | 1, 898, 626 |
| December | 1, 550, 902 | 2, 499, 158 |

## VALUE OF CRUDE PETROLEUM PRODUCED IN THE PENNSYLVANIA AND NEW YORK OIL FIELD IN 1889.

The total value of the 21,487,435 barrels of petroleum produced in Pennsylvania in 1889 was $23,475,163, an average of $1.09¼ per barrel. Of the total production 21,393,159 barrels were classified as illuminating oil, and was valued at $23,225,453, or $1.08⅝ per barrel. There were 94,276 barrels classed as lubricating oil, which was valued at $249,710, or $2.64⅞ per barrel.

The value of the lubricating oil produced in the Franklin district is discussed in connection with the remarks on the Franklin district. It need only be said here that 3 grades of oil are produced in this district, and are known as Old District, No. 1, and No. 2. The Old District, which was much the largest production, sold for $3.65 per barrel, No. 1 for $2.50, and No. 2 for $1.25, the average, considering the amount sold at each price, being $3.30. The Smiths Ferry lubricating oil, of which 29,000 barrels were produced in 1889, was valued at the same price as other Beaver county oil, namely, $1.19⅛.

The values of the illuminating oils in Pennsylvania are based on the average value of pipe-line certificates. These averages for 1889, by months, were as follows:

MONTHLY AVERAGE PRICE OF PIPE-LINE CERTIFICATES IN 1889.

| | | | |
|---|---|---|---|
| January | $0.86⅝ | July | $0.95⅛ |
| February | 0.89¼ | August | 0.99½ |
| March | 0.90⅞ | September | 0.99⅛ |
| April | 0.88 | October | 1.01⅜ |
| May | 0.83⅛ | November | 1.08½ |
| June | 0.83⅞ | December | 1.04⅛ |

Average, $0.94⅛.

These averages it is to be understood are not true averages, that is, the average which considers both price and quantity sold at that price, but they are the averages of the prices obtained in the different primary markets from day to day, which are the bases of the prices paid by the larger consumer, the Standard Oil Company, for all oil bought by them on that day. It is probable that the true average prices are slightly under the averages usually obtained. These, however, under the circumstances, are the only averages that can be ascertained, and do not vary greatly from the average of the prices.

The only oil that sold at the average in 1889 was that from the Bradford-Allegany district. The oil from each of the other districts commanded a premium above the price of pipe-line certificates, owing to its being better adapted to the production of light products and water-white oil. The average premium, as it was called, in the Forest, Warren, Butler-Clarion-Venango, and Allegheny (Pennsylvania) districts was 20 cents; in the other districts, 25 cents.

The total production, total value, and average value of all of the oil produced in the Pennsylvania and New York district in 1889, by districts, were as follows:

TOTAL PRODUCTION, TOTAL VALUE, AND AVERAGE VALUE OF CRUDE PETROLEUM PRODUCED IN THE PENNSYLVANIA AND NEW YORK DISTRICT IN 1889, BY DISTRICTS.

| DISTRICTS. | ILLUMINATING. | | | LUBRICATING. | | |
|---|---|---|---|---|---|---|
| | Production. (Barrels.) | Value. | Price per barrel. | Production. (Barrels.) | Value. | Price per barrel. |
| Total | 21,393,159 | $23,225,453 | $1.08⅝ | 94,276 | $249,710 | $2.64⅞ |
| Bradford-Allegany | 7,158,363 | 6,737,809 | 0.94⅛ | | | |
| Forest | 258,955 | 295,532 | 1.14⅛ | | | |
| Warren | 2,347,434 | 2,679,010 | 1.14⅛ | | | |
| Butler-Clarion-Venango (*a*) | 6,243,522 | 7,125,421 | 1.14⅛ | | | |
| Allegheny, Pennsylvania | 541,092 | 617,512 | 1.14⅛ | | | |
| Beaver | 602,736 | 718,010 | 1.19⅛ | *b*29,000 | 34,546 | 1.19⅛ |
| Washington | 3,848,145 | 4,584,103 | 1.19⅛ | | | |
| Greene | 392,912 | 468,056 | 1.19⅛ | | | |
| Franklin | | | | 65,276 | 215,164 | 3.30 |

*a* Including Tidioute and Titusville district.

*b* Smiths Ferry district.

In the table from Stowell's Petroleum Reporter, given on the following page, will be found the monthly and yearly average of pipe-line certificates or the prices at primary markets of crude petroleum per barrel of 42 gallons from 1865 to 1889, inclusive. The remarks made above regarding the value of these averages should be noted in examining this table; that is, that these are not true average prices, but the average of the prices obtained daily.

### MONTHLY AND YEARLY AVERAGE PRICES OF PIPE-LINE CERTIFICATES OF CRUDE PETROLEUM AT WELLS FROM 1865 TO 1889.

| YEARS. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Yearly. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1865 | $8.25 | $7.50 | $6.00 | $6.00 | $7.37½ | $5.62½ | $5.12½ | $4.62½ | $6.75 | $8.12½ | $7.25 | $6.50 | $6.59 |
| 1866 | 4.50 | 4.40 | 3.75 | 3.95 | 4.50 | 3.87½ | 3.00 | 3.75 | 4.50 | 3.39 | 3.10 | 2.12½ | 3.74 |
| 1867 | 1.87½ | 1.85 | 1.75 | 2.07½ | 2.35 | 1.90 | 2.62½ | 3.15 | 3.40 | 3.55 | 2.50 | 1.87½ | 2.41 |
| 1868 | 1.95 | 2.00 | 2.55 | 2.82⅛ | 3.75 | 4.50 | 5.12½ | 4.57½ | 4.00 | 4.12½ | 3.75 | 4.35 | 3.62½ |
| 1869 | 5.75 | 6.95 | 6.00 | 6.70 | 5.35 | 4.95 | 5.37½ | 5.57½ | 5.50 | 5.50 | 5.80 | 5.12½ | 5.63¾ |
| 1870 | 4.52½ | 4.52½ | 4.45 | 4.22½ | 4.40 | 4.17½ | 3.77½ | 3.15 | 3.25 | 3.27½ | 3.22 | 3.40 | 3.84 |
| 1871 | 3.82½ | 4.38 | 4.25 | 4.01 | 4.60 | 3.85½ | 4.79 | 4.66 | 4.65 | 4.82½ | 4.25 | 4.00 | 4.34 |
| 1872 | 4.02½ | 3.80 | 3.72½ | 3.52½ | 3.80 | 3.85 | 3.80 | 3.58½ | 3.25 | 3.15 | 3.83½ | 3.32½ | 3.63 |
| 1873 | 2.60 | 2.20 | 2.12½ | 2.30 | 2.47½ | 2.22½ | 2.00 | 1.42½ | 1.15 | 1.20 | 1.25 | 1.00 | 1.87 |
| 1874 | 1.20 | 1.40 | 1.60 | 1.90 | 1.62½ | 1.32½ | 1.02½ | 0.95 | 0.95 | 0.85 | 0.55 | 0.61½ | 1.15 |
| 1875 | 1.03 | 1.52½ | 1.75 | 1.36½ | 1.40 | 1.26½ | 1.09 | 1.13 | 1.33 | 1.32½ | 1.44 | 1.55 | 1.36 |
| 1876 | 1.80 | 2.60 | 2.01 | 2.02½ | 1.90½ | 2.01¾ | 2.24½ | 2.71⅜ | 3.81 | 3.37½ | 3.11 | 3.73 | 2.56¼ |
| 1877 | 3.53¼ | 2.70 | 2.67½ | 2.58 | 2.24 | 1.94⅝ | 2.07½ | 2.51 | 2.38 | 2.56¾ | 1.91 | 1.80 | 2.42 |
| 1878 | 1.43 | 1.65¼ | 1.59 | 1.37½ | 1.35¼ | 1.14 | 0.98¾ | 1.01 | 0.86⅝ | 0.82⅛ | 0.89⅜ | 1.16 | 1.19 |
| 1879 | 1.03 | 0.98 | 0.86¼ | 0.78½ | 0.76 | 0.68⅜ | 0.69⅞ | 0.67⅛ | 0.69⅜ | 0.88⅛ | 1.05⅝ | 1.18⅛ | 0.85⅞ |
| 1880 | 1.10¼ | 1.03⅛ | 0.88¾ | 0.78 | 0.80 | 1.00 | 1.06¼ | 0.91 | 0.96 | 0.96⅞ | 0.91⅞ | 0.91⅝ | 0.94½ |
| 1881 | 0.95½ | 0.90⅜ | 0.83⅜ | 0.86¼ | 0.81⅞ | 0.81¼ | 0.76⅞ | 0.78⅛ | 0.97⅛ | 0.91¼ | 0.85¼ | 0.84⅜ | 0.85⅞ |
| 1882 | 0.83⅛ | 0.84½ | 0.81⅜ | 0.78⅞ | 0.71½ | 0.54⅜ | 0.57⅜ | 0.58⅝ | 0.72⅛ | 0.93¾ | 1.14 | 0.96 | 0.78⅛ |
| 1883 | 0.93¾ | 1.01 | 0.97⅝ | 0.94⅜ | 1.00⅛ | 1.16⅜ | 1.05⅞ | 1.08 | 1.12½ | 1.11⅛ | 1.14½ | 1.14¾ | 1.05¾ |
| 1884 | 1.11 | 1.04⅜ | 0.98⅛ | 0.94 | 0.85⅝ | 0.68⅝ | 0.63½ | 0.81⅞ | 0.78 | 0.71⅛ | 0.72½ | 0.74⅜ | 0.83½ |
| 1885 | 0.70⅞ | 0.72⅜ | 0.80⅛ | 0.78½ | 0.79 | 0.82 | 0.92½ | 1.00¼ | 1.00¾ | 1.05½ | 1.04⅜ | 0.89⅝ | 0.87⅞ |
| 1886 | 0.88⅜ | 0.79⅞ | 0.77¼ | 0.74⅛ | 0.70 | 0.66½ | 0.66 | 0.62⅛ | 0.63⅜ | 0.65⅛ | 0.71⅝ | 0.70⅝ | 0.71¼ |
| 1887 | 0.70 | 0.64⅝ | 0.63⅜ | 0.64⅞ | 0.64⅛ | 0.62⅝ | 0.59⅛ | 0.60⅛ | 0.67 | 0.70⅞ | 0.73⅞ | 0.80¾ | 0.66¾ |
| 1888 | 0.91¼ | 0.91⅝ | 0.93⅝ | 0.82⅝ | 0.86¾ | 0.75⅞ | 0.80⅝ | 0.90⅛ | 0.93⅝ | 0.90⅝ | 0.85⅜ | 0.89¼ | 0.87⅝ |
| 1889 | 0.86⅝ | 0.89¼ | 0.90⅞ | 0.88 | 0.83⅛ | 0.83⅞ | 0.95⅛ | 0.99½ | 0.99⅛ | 1.01⅜ | 1.08½ | 1.04⅛ | 0.94⅛ |

### SHIPMENTS OF PETROLEUM FROM PENNSYLVANIA AND NEW YORK.

In the following table will be found a statement of the number of barrels of crude petroleum and of refined petroleum reduced to its equivalent shipped out of the Pennsylvania and New York oil regions either by pipe line or railroad from 1871 to 1889, inclusive. In some years, especially in the earlier ones covered by this table, a considerable portion of the oil was shipped as refined. In this table that is reduced to its equivalent in crude, a barrel of refined being regarded as being produced from 1⅓ barrels of crude.

### SHIPMENTS OF CRUDE PETROLEUM AND REFINED PETROLEUM, REDUCED TO CRUDE EQUIVALENT, OUT OF THE PENNSYLVANIA AND NEW YORK OIL FIELDS FOR THE YEARS 1871-1889, BY MONTHS AND YEARS.

[Barrels.]

| YEARS. | Total. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1871 | 5,664,791 | 437,691 | 347,718 | 383,890 | 389,147 | 587,375 | 501,754 | 541,137 | 528,134 | 551,075 | 505,071 | 480,977 | 410,822 |
| 1872 | 5,899,947 | 476,966 | 407,606 | 276,220 | 428,512 | 510,417 | 529,228 | 591,238 | 621,954 | 541,607 | 607,468 | 477,945 | 430,786 |
| 1873 | 9,499,775 | 573,124 | 527,440 | 668,374 | 708,191 | 768,176 | 696,414 | 814,449 | 864,768 | 952,955 | 1,010,852 | 959,589 | 955,443 |
| 1874 | 8,821,500 | 843,663 | 501,220 | 518,246 | 803,409 | 899,027 | 815,413 | 940,281 | 793,865 | 1,014,570 | 543,341 | 546,117 | 602,348 |
| 1875 | 8,942,938 | 453,095 | 327,776 | 693,918 | 729,581 | 681,679 | 745,986 | 904,537 | 882,089 | 1,109,392 | 871,917 | 671,066 | 871,902 |
| 1876 | 10,164,452 | 677,289 | 519,193 | 623,762 | 603,037 | 646,150 | 921,862 | 1,228,539 | 1,203,402 | 1,154,549 | 524,190 | 871,496 | 1,190,983 |
| 1877 | 12,832,573 | 743,461 | 484,904 | 913,919 | 903,526 | 1,234,324 | 1,391,124 | 1,096,951 | 1,425,943 | 1,563,797 | 1,268,971 | 1,205,634 | 600,019 |
| 1878 | 13,676,000 | 775,791 | 774,234 | 741,512 | 846,632 | 960,894 | 1,135,119 | 1,330,454 | 1,655,651 | 1,434,225 | 1,747,390 | 1,281,410 | 992,688 |
| 1879 | 15,886,470 | 663,998 | 702,729 | 973,879 | 1,136,188 | 1,331,469 | 1,369,314 | 1,625,035 | 1,808,239 | 1,627,120 | 1,662,269 | 1,453,645 | 1,532,585 |
| 1880 | 15,677,492 | 1,650,409 | 1,395,151 | 1,613,371 | 842,268 | 1,095,259 | 975,083 | 1,231,611 | 1,394,129 | 1,252,635 | 1,665,933 | 1,226,030 | 1,335,613 |
| 1881 | 20,284,235 | 1,061,617 | 915,028 | 1,276,746 | 1,348,398 | 1,563,436 | 1,729,697 | 1,925,532 | 2,214,877 | 2,131,950 | 2,080,467 | 2,066,906 | 1,969,581 |
| 1882 | 21,900,314 | 1,657,067 | 1,787,909 | 1,718,956 | 1,678,134 | 1,827,356 | 2,172,685 | 2,402,970 | 2,047,545 | 1,992,171 | 2,089,428 | 1,404,640 | 1,121,453 |
| 1883 | 21,979,369 | 1,357,815 | 1,250,824 | 1,641,899 | 1,908,379 | 1,995,634 | 1,747,789 | 1,634,407 | 2,086,478 | 2,325,574 | 2,215,421 | 2,065,602 | 1,749,547 |
| 1884 | 23,657,597 | 1,686,961 | 1,723,261 | 1,873,890 | 1,643,336 | 1,899,329 | 1,827,553 | 1,740,021 | 2,000,371 | 2,292,087 | 2,510,283 | 2,078,261 | 2,382,244 |
| 1885 | 23,713,326 | 1,804,028 | 1,895,021 | 1,887,034 | 1,823,726 | 2,097,099 | 2,034,025 | 1,961,152 | 2,049,099 | 2,116,659 | 2,050,150 | 1,857,080 | 2,138,253 |
| 1886 | 26,653,852 | 1,991,561 | 2,032,794 | 2,055,750 | 2,070,468 | 2,032,672 | 2,117,489 | 2,418,961 | 2,059,299 | 2,157,323 | 2,441,848 | 2,724,796 | 2,550,891 |
| 1887 | 27,279,028 | 2,312,067 | 1,995,757 | 2,332,324 | 1,938,278 | 2,328,564 | 2,165,439 | 2,000,173 | 2,220,768 | 2,342,227 | 2,573,008 | 2,462,082 | 2,608,341 |
| 1888 | 25,138,031 | 2,265,109 | 2,163,957 | 1,979,753 | 1,928,435 | 1,773,994 | 1,956,115 | 2,098,531 | 2,223,263 | 2,289,486 | 1,558,115 | 2,503,491 | 2,397,782 |
| 1889 | 29,638,898 | 2,388,609 | 2,272,060 | 2,263,009 | 2,236,004 | 2,256,122 | 2,268,280 | 2,949,597 | 2,625,825 | 2,567,459 | 2,747,284 | 2,393,131 | 2,671,518 |

These shipments are, for the latter years, chiefly what are known as pipe-line deliveries. It will be seen that the shipments for 1889 were the largest in the history of the trade, being 2,359,870 barrels greater than in 1887, the year of the largest previous shipment, when the total shipments were 27,279,028 barrels. It will also be noted that the shipments were over 8,000,000 barrels in excess of the production. This increased shipment makes itself very manifest in the statement of stocks held in the Pennsylvania and New York oil regions at the close of 1889, which are given below.

These figures of shipments must not be taken as showing the actual consumption of oil. To them must be added, in order to ascertain what becomes of the oil produced in the oil regions, all of the sediment, the dump oil, or oil that does not pass through the pipe line, as well as the amount of oil destroyed by fire and disposed of in other ways than by refining or direct consumption. There is also a certain amount of loss by evaporation and otherwise. This is provided for by the pipe lines in receiving the oil from the producers, a certain number of gallons per barrel being allowed for such loss. 44 gallons are generally delivered by the producer to the pipe line as a barrel, but certificates are issued for barrels of 42 gallons only.

### STOCKS OF CRUDE PETROLEUM IN THE PENNSYLVANIA AND NEW YORK OIL FIELDS.

The reduction in stocks of petroleum held by the pipe lines in 1889 was most notable. The stocks at the close of that year, as will be seen in the following table, were less than at any time since 1879, being on December 31, 1889, 11,562,593 barrels, compared with 8,470,490 barrels at the close of 1879. Between 1879 and 1889 the stocks had risen to 37,366,126 barrels at the close of December, 1884. From this there was a gradual reduction until 1887, when the stocks stood 28,006,211 barrels on December 31 of that year, from which they dropped a little more than 9,000,000 barrels, or to 18,995,814, at the close of 1888, and to 11,562,593 at the close of 1889, notwithstanding, as has already been pointed out, the greatly increased production in 1889 over 1888. This increase, as above stated, in the Pennsylvania and New York oil fields was 4,998,767 barrels, yet the decrease in stocks was 7,433,221 barrels.

The following table shows the total stocks of crude petroleum in the Pennsylvania and New York oil fields from 1871 to 1889, by months and years:

TOTAL STOCKS OF CRUDE PETROLEUM IN THE PENNSYLVANIA AND NEW YORK OIL FIELDS FOR THE YEARS 1871-1889, BY MONTHS AND YEARS.

[Barrels.]

| YEARS. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Averages. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1871 | 537, 751 | 587, 021 | 642, 000 | 771, 000 | 605, 000 | 554, 000 | 511, 220 | 530, 146 | 541, 300 | 495, 102 | 502, 960 | 532, 000 | 567, 458 |
| 1872 | 532, 971 | 579, 793 | 662, 497 | 877, 832 | 950, 803 | 1, 010, 302 | 990, 229 | 997, 166 | 951, 410 | 914, 423 | 886, 909 | 1, 084, 423 | 869, 897 |
| 1873 | 1, 183, 728 | 1, 265, 373 | 1, 244, 657 | 1, 178, 643 | 1, 192, 541 | 1, 324, 493 | 1, 433, 620 | 1, 513, 890 | 1, 521, 185 | 1, 452, 777 | 1, 493, 875 | 1, 625, 157 | 1, 369, 162 |
| 1874 | 1, 948, 919 | 2, 283, 032 | 2, 648, 210 | 2, 623, 534 | 2, 594, 286 | 2, 701, 625 | 2, 279, 479 | 2, 932, 444 | 2, 758, 504 | 3, 134, 902 | 3, 449, 845 | 3, 705, 639 | 2, 755, 035 |
| 1875 | 4, 011, 703 | 4, 546, 188 | 4, 592, 364 | 4, 537, 843 | 4. 552, 672 | 4, 502, 896 | 4, 386, 720 | 4, 223, 397 | 3, 812, 945 | 3, 672, 101 | 3, 701, 235 | 3, 550, 207 | 4, 174, 189 |
| 1876 | 3, 585, 143 | 3, 734, 835 | 3, 829, 250 | 3, 900, 703 | 3, 989, 904 | 3, 791, 642 | 3, 326, 726 | 3, 304, 405 | 2, 930, 456 | 3, 040, 108 | 2, 955, 092 | 2, 551, 199 | 3, 411, 622 |
| 1877 | 2, 604, 128 | 2, 860, 636 | 3, 210, 454 | 3, 279, 731 | 3, 173, 008 | 2, 912, 674 | 3, 004, 728 | 2, 852, 544 | 2, 503, 657 | 2, 504, 012 | 2, 471, 798 | 3, 127, 837 | 2, 875, 434 |
| 1878 | 3, 555, 342 | 3, 875, 964 | 4, 342, 832 | 4, 692, 090 | 4. 996, 058 | 5, 078, 189 | 5, 031, 600 | 4, 717, 877 | 4, 599, 362 | 4, 221, 769 | 4, 289, 309 | 4, 615, 299 | 4, 501, 308 |
| 1879 | 5, 321, 222 | 5, 813, 663 | 6, 318, 099 | 6, 689, 111 | 6, 980, 064 | 7, 263, 150 | 7, 353, 382 | 7, 114, 195 | 7, 620, 525 | 7, 794, 634 | 8, 051, 469 | 8, 470, 490 | 7, 065, 834 |
| 1880 | 8, 724, 194 | 9, 004, 062 | 9, 606, 683 | 10, 780, 153 | 11, 916, 577 | 13, 099, 934 | 14, 116, 753 | 15, 063, 651 | 16, 157, 316 | 16, 877, 019 | 18, 025, 409 | 18, 928, 430 | 13, 525, 015 |
| 1881 | 20, 110, 903 | 21, 108, 003 | 22, 105, 789 | 22, 963, 171 | 23, 793, 028 | 24, 441, 191 | 24, 888, 337 | 25, 005, 187 | 25, 066, 657 | 25, 309, 361 | 25, 509, 285 | 26, 019, 704 | 23, 860, 051 |
| 1882 | 26, 716, 188 | 27, 059, 611 | 27, 822, 825 | 28, 547, 481 | 29, 206, 697 | 29, 859, 952 | 30, 715, 144 | 31, 772, 094 | 32, 400, 303 | 32, 608, 533 | 33, 728, 555 | 34, 596. 612 | 30, 419, 500 |
| 1883 | 35, 187, 116 | 35, 692, 480 | 35, 881, 255 | 37, 789, 406 | 35, 755, 824 | 35, 985, 935 | 36, 371, 922 | 36, 164, 881 | 35, 752, 677 | 35, 613, 915 | 35, 506, 653 | 35, 745, 632 | 35, 953, 975 |
| 1884 | 35, 884, 509 | 36, 041, 898 | 36, 220, 270 | 36, 642, 794 | 38, 631, 203 | 38, 665, 838 | 38, 985, 767 | 39, 084, 561 | 38, 740, 734 | 38, 192, 317 | 37, 925, 756 | 37, 366, 126 | 37, 698, 481 |
| 1885 | 37, 214, 274 | 36, 757, 137 | 36, 508, 236 | 36, 464, 800 | 36, 139, 072 | 35, 872, 257 | 35, 686, 909 | 35, 343, 771 | 34, 939, 902 | 34, 763, 857 | 34, 668, 437 | 34, 428, 841 | 35, 732, 291 |
| 1886 | 34, 186, 238 | 34, 082, 775 | 33, 954. 493 | 33, 823, 385 | 33, 969, 486 | 34, 187, 377 | 34, 428, 490 | 34, 800, 397 | 35, 061, 614 | 35, 027, 877 | 34, 525, 871 | 34, 156, 605 | 34, 350, 384 |
| 1887 | 33, 835, 389 | 33, 288, 630 | 32, 932, 502 | 32, 955, 084 | 32, 642, 330 | 32, 389, 750 | 32, 289, 269 | 32, 003, 536 | 31, 340, 939 | 30, 662, 583 | 29, 325, 951 | 28, 006, 211 | 31, 806, 015 |
| 1888 | 26, 927, 634 | 26, 084, 574 | 25, 404, 276 | 24, 893, 223 | 24, 653, 043 | 24, 219, 496 | 23, 586, 951 | 22, 825, 298 | 21, 876, 681 | 20, 722, 024 | 19, 734, 132 | 18, 995, 814 | 23, 326, 929 |
| 1889 | 18, 165, 607 | 17, 240, 428 | 16, 634, 437 | 16, 076, 501 | 15, 668, 331 | 15, 258, 863 | 14, 541, 696 | 13, 859, 267 | 13, 198, 452 | 12, 468, 969 | 12, 021, 924 | 11, 562, 593 | 14, 724, 756 |

For the last 2 years the total stocks of petroleum as given in the foregoing table are in excess of those held by the pipe lines. The stocks given in the table include, in addition to those held by the pipe lines, all that are held at wells, but not those of crude held at refineries.

### WELL RECORDS IN THE PENNSYLVANIA AND NEW YORK OIL FIELDS.

In the tables following are given what are known as the well records; that is, the statistics of the drilling of new wells and the number of producing wells in Pennsylvania and New York. New York is included in this well report for reasons previously given, namely, that in the pipe line reports it is so difficult to arrive at the exact statistics of production in the oil territory in New York contiguous to Pennsylvania, the oil pools running from one state into the other and the oil being run through pipe lines to a common receptacle, often without any opportunity of measuring the oil from different wells in the different states belonging to the same parties.

In the following table is shown the number of rigs building, preparatory to drilling wells, at the close of each month of 1889, by districts and by totals:

NUMBER OF RIGS BUILDING IN THE PENNSYLVANIA AND NEW YORK OIL FIELDS AT THE CLOSE OF EACH MONTH DURING 1889, BY DISTRICTS.

| MONTHS. | Total. | Bradford-Allegany. | Forest. | Warren. | Butler-Clarion-Venango. | Washington. | Allegheny. | Beaver. | Greene. |
|---|---|---|---|---|---|---|---|---|---|
| Total | 3,829 | 770 | 58 | 276 | 1,808 | 497 | 240 | 62 | 118 |
| January | 219 | 26 | 3 | 18 | 108 | 37 | 19 | 1 | 7 |
| February | 229 | 27 | 12 | 1 | 132 | 34 | 18 | ......... | 5 |
| March | 311 | 55 | 2 | 33 | 153 | 43 | 18 | ......... | 7 |
| April | 267 | 52 | 1 | 16 | 134 | 33 | 17 | 7 | 7 |
| May | 279 | 45 | 2 | 14 | 122 | 50 | 34 | ......... | 12 |
| June | 278 | 55 | 1 | 13 | 126 | 36 | 33 | 7 | 7 |
| July | 246 | 53 | 6 | 13 | 107 | 34 | 29 | ......... | 4 |
| August | 351 | 81 | 6 | 34 | 144 | 46 | 22 | ......... | 18 |
| September | 347 | 58 | 3 | 34 | 179 | 18 | 27 | 13 | 15 |
| October | 427 | 102 | 9 | 46 | 191 | 42 | 12 | 15 | 10 |
| November | 453 | 120 | 11 | 27 | 199 | 64 | 6 | 14 | 12 |
| December | 422 | 96 | 2 | 27 | 213 | 60 | 5 | 5 | 14 |

From this it will be seen that the number of rigs building increased from January to March, was stationary to the close of June, declined a little in July, increased rapidly from August to November, when the number was 453, the largest number during the year.

In the following table is given the number of wells actually drilling at the close of each month in 1889, by districts. This includes only drilling wells, excluding rigs building and wells actually completed during or at the close of the month.

NUMBER OF WELLS DRILLING AT THE CLOSE OF EACH MONTH IN 1889, BY DISTRICTS.

| MONTHS. | Total. | Bradford-Allegany. | Forest. | Warren. | Butler-Clarion-Venango. | Washington. | Allegheny. | Beaver. | Greene. |
|---|---|---|---|---|---|---|---|---|---|
| Total | 6,580 | 1,154 | 85 | 406 | 2,497 | 1,550 | 600 | 54 | 234 |
| January | 341 | 45 | 3 | 19 | 174 | 56 | 22 | 2 | 20 |
| February | 350 | 50 | 17 | 5 | 151 | 92 | 13 | ......... | 22 |
| March | 453 | 63 | 3 | 44 | 186 | 113 | 25 | ......... | 19 |
| April | 487 | 79 | 3 | 16 | 179 | 143 | 41 | 7 | 19 |
| May | 574 | 93 | 2 | 43 | 206 | 132 | 79 | ......... | 19 |
| June | 612 | 76 | 5 | 34 | 205 | 170 | 105 | 1 | 16 |
| July | 598 | 97 | 4 | 36 | 193 | 148 | 113 | 5 | 2 |
| August | 598 | 113 | 6 | 49 | 194 | 148 | 61 | ......... | 27 |
| September | 600 | 85 | 9 | 43 | 230 | 142 | 59 | 10 | 22 |
| October | 698 | 166 | 14 | 35 | 273 | 150 | 28 | 13 | 19 |
| November | 659 | 139 | 9 | 37 | 275 | 124 | 35 | 12 | 28 |
| December | 610 | 148 | 10 | 45 | 231 | 132 | 19 | 4 | 21 |

About the same remarks may be made on this table as were made in regard to that showing the number of rigs building, except that the increase was a gradual one from the beginning of the year to the last of June, and was then stationary until the last of September, increasing over 16 per cent in October, making the total number of wells drilling at the close of October 698, the largest number of wells drilling at the close of any one month during the period covered by the table given on the following page, or from 1871 to 1889.

### NUMBER OF DRILLING WELLS IN THE PENNSYLVANIA AND NEW YORK OIL FIELDS AT THE CLOSE OF EACH MONTH FOR THE YEARS 1871–1889, BY MONTHS AND YEARS.

| YEARS. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Averages. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1871 | 140 | 173 | 240 | 279 | 356 | 303 | 329 | 330 | 439 | 486 | 477 | 394 | 329 |
| 1872 | 363 | 369 | 313 | 302 | 386 | 391 | 359 | 392 | 301 | 311 | 354 | 318 | 347 |
| 1873 | 361 | 349 | 227 | 177 | 228 | 395 | 340 | 267 | 197 | 163 | 137 | 60 | 242 |
| 1874 | 37 | 55 | 99 | 213 | 225 | 210 | 180 | 128 | 107 | 82 | 57 | 54 | 121 |
| 1875 | 40 | 40 | 45 | 64 | 127 | 162 | 118 | 96 | 132 | 170 | 179 | 168 | 112 |
| 1876 | 142 | 151 | 230 | 267 | 307 | 340 | 353 | 374 | 511 | 565 | 618 | 493 | 363 |
| 1877 | 457 | 463 | 395 | 448 | 512 | 395 | 365 | 417 | 535 | 573 | 565 | 426 | 463 |
| 1878 | 334 | 326 | 379 | 409 | 376 | 266 | 188 | 185 | 240 | 282 | 297 | 218 | 292 |
| 1879 | 265 | 323 | 406 | 468 | 460 | 384 | 329 | 258 | 270 | 313 | 372 | 440 | 357 |
| 1880 | 540 | 535 | 577 | 580 | 460 | 440 | 452 | 515 | 491 | 469 | 475 | 408 | 405 |
| 1881 | 383 | 420 | 437 | 446 | 470 | 408 | 379 | 352 | 388 | 445 | 475 | 468 | 423 |
| 1882 | 422 | 438 | 408 | 405 | 381 | 226 | 240 | 194 | 177 | 184 | 154 | 138 | 281 |
| 1883 | 126 | 151 | 205 | 199 | 216 | 228 | 262 | 315 | 314 | 341 | 301 | 263 | 243 |
| 1884 | 270 | 273 | 260 | 284 | 244 | 123 | 123 | 91 | 79 | 100 | 86 | 78 | 168 |
| 1885 | 97 | 109 | 139 | 190 | 228 | 200 | 242 | 308 | 382 | 355 | 359 | 277 | 241 |
| 1886 | 320 | 337 | 356 | 318 | 358 | 403 | 349 | 290 | 322 | 272 | 285 | 238 | 321 |
| 1887 | 201 | 177 | 155 | 155 | 157 | 142 | 135 | 137 | 107 | 104 | 114 | 88 | 139 |
| 1888 | 64 | 72 | 65 | 59 | 82 | 106 | 124 | 106 | 166 | 187 | 327 | 273 | 136 |
| 1889 | 341 | 350 | 453 | 487 | 574 | 612 | 598 | 598 | 600 | 698 | 659 | 610 | 548 |

The effect of the increased demand for petroleum and the decrease in stocks, shown in previous tables, and the reduction of production, owing to the shut-down in 1888, will be seen by comparing the figures of wells drilling in 1888 and 1889, as shown in the above table. It will be remembered that the shut-in began in November, 1887, and lasted until November, 1888. In January, 1888, there were but 64 wells drilling, as compared with 341 in the same month of 1889. The average for 1888 was 136 wells, as compared with 548 for 1889.

In the following table is given a statement of the number of wells completed in each district in the Pennsylvania and New York oil fields during each month of 1889, by months and districts:

### NUMBER OF WELLS COMPLETED IN THE PENNSYLVANIA AND NEW YORK OIL FIELDS IN 1889, BY MONTHS AND DISTRICTS.

| MONTHS. | Total. | Bradford-Allegany. | Forest. | Warren. | Butler-Clarion-Venango. | Washington. | Allegheny. | Beaver. | Greene. |
|---|---|---|---|---|---|---|---|---|---|
| Total | a5,435 | 1,034 | 55 | 636 | 2,685 | 577 | 231 | 83 | 98 |
| January | 284 | 39 | 4 | 32 | 180 | 16 | 7 | .......... | 6 |
| February | 288 | 34 | 1 | 16 | 207 | 10 | 14 | .......... | 6 |
| March | 353 | 52 | 2 | 38 | 196 | 49 | 8 | .......... | 8 |
| April | 401 | 59 | 1 | 52 | 224 | 51 | 6 | 3 | 5 |
| May | 431 | 82 | 4 | 46 | 207 | 47 | 34 | .......... | 11 |
| June | 537 | 83 | 4 | 71 | 275 | 54 | 34 | 4 | 12 |
| July | 549 | 107 | 9 | 62 | 228 | 60 | 69 | .......... | 14 |
| August | 508 | 104 | 7 | 65 | 233 | 71 | 23 | .......... | 5 |
| September | 478 | 97 | 2 | 70 | 222 | 50 | 5 | 26 | 6 |
| October | 559 | 143 | 7 | 62 | 250 | 59 | 18 | 8 | 12 |
| November | 540 | 121 | 9 | 72 | 252 | 56 | 5 | 15 | 10 |
| December | 471 | 113 | 5 | 50 | 211 | 54 | 8 | 27 | 3 |

*a* Including 36 wells drilled in Franklin district, data for which by months were not obtainable.

From this it will be seen that the total number of wells completed in 1889 was 5,435, as compared with 1,515 in 1888. This is the largest number of wells completed in these states in any one year, the nearest approach to it being in 1880, when 4,217 wells were completed.

The table on the following page gives the number of drilling wells completed in each month from January, 1872, to the close of 1889.

### NUMBER OF DRILLING WELLS COMPLETED IN THE PENNSYLVANIA AND NEW YORK OIL FIELDS EACH MONTH FOR THE YEARS 1872–1889, BY MONTHS AND YEARS.

| YEARS. | Total. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1872 | 1, 183 | 37 | 120 | 89 | 121 | 135 | 84 | 128 | 118 | 82 | 100 | 64 | 105 |
| 1873 | 1, 263 | 93 | 94 | 100 | 105 | 102 | 130 | 114 | 120 | 106 | 101 | 100 | 98 |
| 1874 | 1, 317 | 102 | 104 | 110 | 113 | 109 | 101 | 121 | 107 | 104 | 120 | 106 | 120 |
| 1875 | 2, 398 | 190 | 187 | 195 | 186 | 172 | 190 | 200 | 210 | 201 | 220 | 217 | 230 |
| 1876 | 2, 920 | 240 | 231 | 242 | 200 | 202 | 261 | 248 | 270 | 209 | 273 | 272 | 272 |
| 1877 | 3, 939 | 281 | 241 | 291 | 269 | 320 | 403 | 317 | 255 | 322 | 467 | 391 | 382 |
| 1878 | 3, 064 | 274 | 226 | 211 | 409 | 470 | 269 | 203 | 186 | 174 | 229 | 248 | 165 |
| 1879 | 3, 048 | 136 | 132 | 238 | 270 | 402 | 330 | 327 | 283 | 210 | 232 | 227 | 261 |
| 1880 | 4, 217 | 320 | 230 | 367 | 500 | 426 | 310 | 338 | 368 | 356 | 364 | 336 | 302 |
| 1881 | 3, 880 | 222 | 220 | 271 | 316 | 406 | 374 | 336 | 332 | 312 | 322 | 363 | 406 |
| 1882 | 3, 304 | 347 | 340 | 385 | 432 | 469 | 340 | 185 | 253 | 164 | 117 | 150 | 122 |
| 1883 | 2, 847 | 125 | 126 | 142 | 209 | 231 | 228 | 261 | 309 | 321 | 321 | 302 | 272 |
| 1884 | 2, 265 | 229 | 227 | 256 | 298 | 311 | 244 | 268 | 145 | 89 | 59 | 73 | 66 |
| 1885 | 2, 761 | 64 | 62 | 82 | 116 | 213 | 242 | 217 | 283 | 356 | 397 | 384 | 345 |
| 1886 | 3, 478 | 270 | 280 | 291 | 328 | 343 | 365 | 357 | 313 | 253 | 272 | 221 | 185 |
| 1887 | 1, 660 | 158 | 162 | 138 | 160 | 148 | 162 | 159 | 142 | 134 | 100 | 101 | 96 |
| 1888 | 1, 515 | 57 | 52 | 56 | 49 | 56 | 97 | 82 | 96 | 132 | 229 | 307 | 302 |
| 1889 | *a*5, 435 | 284 | 288 | 353 | 401 | 431 | 537 | 549 | 508 | 478 | 550 | 540 | 471 |

*a* Including 36 wells drilled in Franklin district, data for which by months were not obtainable.

In the following table is given the number of dry holes, that is, the number of wells drilled that produced no oil, in New York and Pennsylvania in 1889:

### NUMBER OF DRY HOLES DRILLED IN THE PENNSYLVANIA AND NEW YORK OIL FIELDS IN 1889, BY MONTHS AND DISTRICTS.

| MONTHS. | Total. | Bradford-Allegany. | Forest. | Warren. | Butler-Clarion-Venango. | Washington. | Allegheny. | Beaver. | Greene. |
|---|---|---|---|---|---|---|---|---|---|
| Total | 875 | *a*81 | 9 | 40 | 546 | 66 | 73 | 13 | 47 |
| January | 66 | 6 | 2 | 5 | 47 | 2 | 2 | .......... | 2 |
| February | 66 | 4 | .......... | 1 | 56 | 1 | 2 | .......... | 2 |
| March | 59 | 7 | .......... | 2 | 41 | 1 | 1 | .......... | 7 |
| April | 79 | 1 | .......... | 6 | 57 | 10 | 2 | .......... | 3 |
| May | 83 | 8 | .......... | 4 | 48 | 5 | 10 | .......... | 8 |
| June | 99 | 8 | 1 | 3 | 60 | 6 | 15 | 3 | 3 |
| July | 91 | 4 | 2 | 2 | 46 | 6 | 21 | .......... | 10 |
| August | 68 | 3 | .......... | *b*5 | 45 | 7 | 5 | .......... | 2 |
| September | 67 | 10 | .......... | 3 | 38 | 3 | 2 | 7 | 4 |
| October | 78 | 13 | 1 | 1 | 45 | 6 | 6 | 3 | 3 |
| November | 68 | 7 | 3 | 6 | 36 | 11 | 2 | .......... | 3 |
| December | 51 | 10 | .......... | 1 | 27 | 8 | 5 | .......... | .......... |

*a* 9 gas wells.

*b* 1 gas well.

The total production of the new wells completed during 1889 is shown in the following table:

### INITIAL DAILY PRODUCTION OF NEW WELLS IN THE PENNSYLVANIA AND NEW YORK OIL FIELDS IN 1889, BY MONTHS AND DISTRICTS.

[Barrels.]

| MONTHS. | Total. | Bradford-Allegany. | Forest. | Warren. | Butler-Clarion-Venango. | Washington. | Allegheny. | Beaver. | Greene. |
|---|---|---|---|---|---|---|---|---|---|
| Total | *a*71, 323 | 6, 863 | 478 | 3, 210 | 22, 813 | 26, 297 | 6, 223 | 2, 572 | 2, 745 |
| January | 2, 777 | 219 | 11 | 133 | 1, 254 | 730 | 200 | .......... | 230 |
| February | 3, 042 | 296 | 10 | 79 | 1, 500 | 473 | 544 | .......... | 140 |
| March | 6, 504 | 291 | 12 | 187 | 1, 666 | 4, 048 | 275 | .......... | 25 |
| April | 3, 817 | 396 | 8 | 169 | 1, 686 | 1, 100 | 183 | 30 | 245 |
| May | 5, 931 | 454 | 24 | 340 | 1, 561 | 2, 594 | 818 | .......... | 140 |
| June | 7, 193 | 529 | 85 | 344 | 2, 055 | 3, 152 | 588 | 15 | 425 |
| July | 6, 832 | 643 | 65 | 232 | 1, 590 | 2, 815 | 1, 387 | .......... | 100 |
| August | 7, 712 | 757 | 68 | 306 | 2, 501 | 3, 246 | 469 | .......... | 365 |
| September | 6, 684 | 652 | 15 | 217 | 2, 427 | 2, 433 | 270 | 660 | 10 |
| October | 6, 118 | 905 | 84 | 495 | 1, 981 | 1, 883 | 292 | 235 | 243 |
| November | 8, 107 | 854 | 60 | 342 | 2, 710 | 1, 761 | 800 | 1, 080 | 500 |
| December | 6, 484 | 867 | 36 | 366 | 1, 882 | 2, 062 | 397 | 552 | 322 |

*a* Including 122 barrels in Franklin district, data for which by months were not obtainable.

The average daily production of the new wells completed in the Pennsylvania and New York oil fields from 1882 to 1889 is as follows:

AVERAGE DAILY PRODUCT OF THE NEW WELLS IN THE PENNSYLVANIA AND NEW YORK OIL FIELDS FROM 1882 TO 1889, BY MONTHS AND YEARS.

[Barrels.]

| MONTHS. | 1882. | 1883. | 1884. | 1885. | 1886. | 1887. | 1888. | 1889. |
|---|---|---|---|---|---|---|---|---|
| January | 19. 50 | 22. 40 | 13. 70 | 40. 00 | 13. 50 | 25. 50 | 15. 43 | 13. 08 |
| February | 19. 40 | 14. 90 | 15. 00 | 41. 30 | 13. 40 | 44. 75 | 12. 48 | 10. 50 |
| March | 22. 25 | 22. 50 | 17. 00 | 23. 30 | 22. 90 | 29. 75 | 66. 00 | 19. 70 |
| April | 22. 00 | 21. 00 | 12. 00 | 40. 00 | 32. 00 | 43. 50 | 9. 40 | 15. 17 |
| May | 21. 30 | 17. 50 | 18. 00 | 23. 00 | 38. 60 | 22. 00 | 68. 71 | 12. 00 |
| June | 36. 80 | 15. 00 | 17. 50 | 10. 60 | 25. 00 | 38. 51 | 40. 55 | 13. 50 |
| July | 108. 80 | 15. 00 | 59. 30 | 10. 30 | 31. 10 | 18. 14 | 14. 38 | 13. 20 |
| August | 84. 20 | 13. 80 | 22. 60 | 10. 60 | 51. 90 | 49. 30 | 19. 00 | 15. 50 |
| September | 25. 75 | 14. 40 | 41. 70 | 13. 20 | 62. 40 | 57. 70 | 19. 00 | 14. 14 |
| October | 15. 90 | 14. 20 | 165. 50 | 14. 00 | 28. 00 | 25. 98 | 13. 72 | 11. 50 |
| November | 12. 90 | 13. 80 | 87. 40 | 10. 90 | 28. 00 | 19. 69 | 12. 80 | 15. 20 |
| December | 20. 40 | 11. 80 | 92. 60 | 10. 90 | 23. 00 | 11. 40 | 13. 30 | 14. 25 |

It will be seen from this table that the average production of each well for 1889 is less than any year covered by the tables.

In the following table is given the number of producing, flowing, and pumping wells in each district of Pennsylvania and New York at the close of 1888 and 1889:

TOTAL NUMBER OF PRODUCING, FLOWING, AND PUMPING WELLS IN THE PENNSYLVANIA AND NEW YORK OIL FIELDS AT THE CLOSE OF 1888 AND 1889.

| DISTRICTS. | TOTAL NUMBER OF PRODUCING WELLS. | | TOTAL NUMBER OF FLOWING WELLS. | | TOTAL NUMBER OF PUMPING WELLS. | |
|---|---|---|---|---|---|---|
| | December 31, 1888. | December 31, 1889. | December 31, 1888. | December 31, 1889. | December 31, 1888. | December 31, 1889. |
| Total | 25, 420 | 31, 768 | 1, 358 | 2, 398 | 24, 062 | 29, 370 |
| Bradford-Allegany | 14, 371 | 16, 293 | 179 | 182 | 14, 192 | 16, 111 |
| Forest | 240 | 299 | 84 | 67 | 156 | 232 |
| Warren | 2, 880 | 4, 178 | 790 | 1, 586 | 2, 090 | 2, 592 |
| Butler-Clarion-Venango-Armstrong, etc | 6, 138 | 8, 336 | 28 | 308 | 6, 110 | 8, 028 |
| Allegheny | 176 | 298 | 160 | 36 | 16 | 262 |
| Beaver and Smiths Ferry | 199 | 270 | 3 | 14 | 196 | 256 |
| Washington | 618 | 1, 232 | 108 | 186 | 510 | 1, 046 |
| Greene | 193 | 231 | 6 | 19 | 187 | 212 |
| Franklin | 605 | 631 | .......... | .......... | 605 | 631 |

From the above table it appears that the number of producing wells in Pennsylvania increased from 25,420 at the close of 1888 to 31,768 at the close of 1889, a total increase of 6,348, though the number of producing wells completed in Pennsylvania and New York in 1889 was but 4,560, leaving an excess of 1,788 wells to be accounted for in addition to the wells that were abandoned in the state during the year. This difference is no doubt due to the fact that a large number of wells which were shut in at the close of 1888, owing to the restriction of production before referred to, were not counted as producing wells. So also a number of wells that were not producing and practically abandoned at the close of 1888 were drilled deeper or cleaned out and became producers in 1889.

As the production of Pennsylvania for the month of December, 1889, was 2,055,247 barrels, it appears that the average production per well for that month was 64.7 barrels, an average of a little over 2 barrels a day. The average for the different districts varies greatly, but can be readily ascertained by dividing the production given on page 441 by the number of wells given above.

The amount of money expended for materials used in pumping, operating, and caring for wells in 1889, including fuel, materials for repairs, replacing old machinery, and materials, was $8,633,391. This is divided among the districts as shown in the statement on the following page.

### VALUE OF MATERIALS USED IN PUMPING, CARING FOR, AND OPERATING WELLS IN THE PENNSYLVANIA AND NEW YORK OIL FIELDS IN 1889, BY DISTRICTS.

| | |
|---|---|
| Bradford-Allegany | $2,603,248 |
| Forest | 29,900 |
| Warren | 1,022,966 |
| Butler-Clarion-Venango-Armstrong, etc | 1,787,296 |
| Allegheny | 215,096 |
| Beaver and Smiths Ferry | 214,026 |
| Washington | 2,454,446 |
| Greene | 274,460 |
| Franklin | 31,953 |
| Total | 8,633,391 |

### WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 25,420 |
| Total number of producing wells December 31, 1889 | 31,768 |
| Total number of flowing wells December 31, 1888 | 1,358 |
| Total number of flowing wells December 31, 1889 | 2,398 |
| Total number of pumping wells December 31, 1888 | 24,062 |
| Total number of pumping wells December 31, 1889 | 29,370 |
| Number of wells completed in 1889 | 5,435 |
| Number of dry holes in 1889 | 875 |
| Number of producing wells completed in 1889 | 4,560 |
| Initial daily production of new wells (barrels) | 71,323 |
| Number of rigs building December 31, 1888 | 179 |
| Number of rigs building December 31, 1889 | 422 |
| Number of wells drilling December 31, 1888 | 273 |
| Number of wells drilling December 31, 1889 | 610 |

### CAPITAL EMPLOYED IN PRODUCING CRUDE PETROLEUM IN PENNSYLVANIA AND NEW YORK OIL FIELDS IN 1889.

The total capital employed in producing crude petroleum in Pennsylvania and New York districts at the close of 1889, according to the table given below, was $89,562,008. Of this, $27,184,857 represented the value of land and $62,377,151 the value of all other property.

The total capital invested in Pennsylvania, the value of lands, and the total amount invested in all other property, by districts, are as follows:

### TOTAL CAPITAL INVESTED IN THE PRODUCTION OF CRUDE PETROLEUM IN PENNSYLVANIA IN 1889, BY DISTRICTS.

| DISTRICTS. | Total capital. | Total value of land. | Total value of all other property. |
|---|---|---|---|
| Total | $89,562,008 | $27,184,857 | $62,377,151 |
| Bradford-Allegany | 32,288,195 | 8,562,827 | 23,725,368 |
| Forest | 1,162,174 | 648,338 | 513,836 |
| Warren | 10,680,618 | 3,971,524 | 6,709,094 |
| Butler-Clarion-Venango-Armstrong, etc | 26,020,574 | 8,322,204 | 17,698,370 |
| Allegheny | 2,070,926 | 739,876 | 1,331,050 |
| Beaver and Smiths Ferry | 2,203,219 | 998,055 | 1,205,164 |
| Washington | 12,238,107 | 2,703,816 | 9,534,291 |
| Greene | 2,171,763 | 978,427 | 1,193,336 |
| Franklin | 726,432 | 259,790 | 466,642 |

The total amount of oil land owned and leased in the Pennsylvania and New York oil regions was 873,399 acres. Of this, 288,510 acres were owned and 584,889 leased. The value given to this land in the schedules was $27,184,857, an average value, ignoring fractions, of $31 an acre. The largest amount of land was held in the Butler-Clarion-Venango-Armstrong district, the smallest amount in the Franklin district. The highest average value per acre was in the Franklin district, being $53 an acre. The lowest value was in the Forest district, the average being $21 an acre. It is evident to any one at all acquainted with oil lands that these averages are very much below the actual value of this territory as oil land. This class of land is worth to-day all the way from $100 to $400 an acre. Recent purchases in the Bradford district, one of the oldest, have been as high, where the fee has been bought, as $150 to $250 an acre, while it is almost impossible to place a value upon oil lands in the Washington district or in several of the newer ones of the southwestern fields. As is stated elsewhere, land was bought in 1889 at a valuation of $1,500 for each barrel of daily production.

In leasing oil lands it is usual to pay a certain price for the lease, varying from $1 to $20 per acre, together with a certain proportion of the oil produced as royalty. This royalty varies from one-sixteenth to one-fourth of the oil produced, the almost universal custom being one-eighth. In estimating the worth of the oil land the value seems to have been put by the producer, so far as it relates to the leased land, at the amount paid per acre for the lease, while probably a fair price, though a low one, has been placed upon the land owned. It is evident, however, that this valuation is not a fair one, as certainly it should be estimated with some reference to the price paid for land when purchased in fee, having in consideration at the same time the amount of oil produced. Under these considerations it is believed that $100 an acre would be a very conservative estimate as the average value per acre of the owned and leased oil lands in Pennsylvania. At this figure the value of these lands would be $87,339,900, instead of $27,184,857.

The number of acres of land held as oil territory in the Pennsylvania and New York oil districts, together with the total value of the same and the value per acre, are as follows:

STATISTICS OF LAND HELD AS OIL TERRITORY IN THE PENNSYLVANIA AND NEW YORK OIL DISTRICTS IN 1889.

| DISTRICTS. | Total acreage. | Owned. (Acres.) | Leased. (Acres.) | Total value of land. | Value per acre. |
|---|---|---|---|---|---|
| Total | 873, 399 | 288, 510 | 584, 889 | $27, 184, 857 | $31 |
| Bradford-Allegany | 182, 861 | 90, 515 | 92, 346 | 8, 562, 827 | 47 |
| Forest | 30, 895 | 12, 194 | 18, 701 | 648, 338 | 21 |
| Warren | 88, 486 | 33, 744 | 54, 742 | 3, 971, 524 | 45 |
| Butler-Clarion-Venango-Armstrong, etc | 351, 278 | 142, 634 | 208, 644 | 8, 322, 204 | 24 |
| Allegheny | 31, 971 | 2, 407 | 29, 564 | 739, 876 | 23 |
| Beaver and Smiths Ferry | 28, 812 | 981 | 27, 831 | 998, 055 | 35 |
| Washington | 112, 137 | 2, 544 | 109, 593 | 2, 703, 816 | 24 |
| Greene | 42, 083 | 275 | 41, 808 | 978, 427 | 23 |
| Franklin | 4, 876 | 3. 216 | 1, 660 | 259, 790 | 53 |

The total capital invested in the production of crude petroleum in Pennsylvania and New York, outside of that invested in lands, amounted in 1889 to $62,377,151. Of this, $55,936,194 was invested in wells, including rigs, wells proper, engines, boilers, casings, etc.; $1,327,614 in tanks; $7,255 in tank cars owned by the producers, but not including those owned by transportation companies; $1,268,928 in pipe lines at wells, but not including the lines owned by the pipe-line transportation companies; $446,305 in oil in stock at wells, and $3,390,855 in other property. One or two of these amounts demand some explanation. It should be distinctly noted that the value of tank cars and pipe lines given above does not include in any case the value of these properties owned by the various pipe-line and other transportation companies, but only the properties of the several kinds mentioned that were actually a part of the well outfit.

The total value of the wells, that is, rigs, wells proper, engines, boilers, and other apparatus, not including tanks, tank cars, or pipe lines, was $55,936,194. On the basis of 31,768 producing wells, this would give an average value of $1,761 per well. The average value of the wells in each district, as shown in the table of capital invested in them, is given below:

AVERAGE VALUE PER WELL IN EACH OF THE DISTRICTS IN THE PENNSYLVANIA AND NEW YORK OIL FIELDS IN 1889.

| | |
|---|---|
| Bradford-Allegany | $1, 237 |
| Forest | 1, 360 |
| Warren | 1, 335 |
| Butler-Clarion-Venango-Armstrong, etc | 1, 998 |
| Allegheny | 4, 297 |
| Beaver and Smiths Ferry | 4, 202 |
| Washington | 7, 428 |
| Greene | 4, 971 |
| Franklin | 690 |

In the older districts it is customary to estimate the value of a well at the price at which the material at the well, including casings, rigs, engines, boilers, etc., could be sold. In the newer districts, especially in the southwestern country, a much higher estimate than this has been made, though even there it is believed that in arriving at the value sufficient account has not been taken of the income that the wells bring to their owners.

The number of producing wells at the beginning of 1889 was 25,420; at the close of 1889 it was 31,768. Assuming that the average number of producing wells throughout the year was in round numbers 28,000, they produced an average of 767 barrels, worth on the average in the neighborhood of $1.10 a barrel, or $844 per well. This number of wells (28,000), producing this value of oil in 1 year, should certainly be worth on an average more than $1,761, when the old materials from these wells will be worth from $1,250 to $1,500 in the upper region, and in the lower fields from $2,000 to $3,000. Some of the wells in the Washington district will probably produce from 50,000 to 75,000 barrels of oil before they are abandoned.

The capital invested in the production of crude petroleum in Pennsylvania and New York, outside of that invested in land, was as follows in 1889, by districts:

| DISTRICTS. | Total. | Rigs, wells, engines, etc. | Tanks. | Tank cars. | Pipe lines. | Oil in stock December 31, 1889. | Other property. |
|---|---|---|---|---|---|---|---|
| Total | $62, 377, 151 | $55, 936, 194 | $1, 327, 614 | $7, 255 | $1, 268, 928 | $446, 305 | $3, 390, 855 |
| Bradford-Allegany | 23, 725, 368 | 20, 149, 046 | 534, 594 | 510 | 681, 549 | 181, 376 | 2, 178, 293 |
| Forest | 513, 836 | 406, 559 | 15, 911 | 495 | 42, 755 | 7, 668 | 40, 448 |
| Warren | 6, 709, 094 | 5, 575, 578 | 160, 376 | ........... | 215, 212 | 60, 820 | 697, 108 |
| Butler-Clarion-Venango-Armstrong, etc | 17, 698, 370 | 16, 654, 912 | 421, 192 | 5, 250 | 233, 300 | 70, 676 | 313, 040 |
| Allegheny | 1, 331, 050 | 1, 280, 455 | 10. 900 | ........... | 4, 771 | 6, 857 | 28, 067 |
| Beaver and Smiths Ferry | 1, 205, 164 | 1, 134, 572 | 21, 046 | ........... | 2, 632 | 18, 904 | 28, 010 |
| Washington | 9, 534, 291 | 9, 151, 407 | 139, 590 | ........... | 81, 819 | 99, 054 | 62, 421 |
| Greene | 1, 193, 336 | 1, 148, 224 | 13, 750 | ........... | 2, 762 | 950 | 27, 650 |
| Franklin | 466, 642 | 435, 441 | 10, 255 | 1, 000 | 4, 128 | ........... | 15, 818 |

The totals of capital, acres of oil land held and its value, and the value of other property for the states of Pennsylvania and New York in 1889, were as follows:

## CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $89, 562, 008 |
| Number of acres of oil land: | | |
| Owned | 288, 510 | |
| Leased | 584, 889 | |
| Total acreage | 873, 399 | |
| Present value of land, both owned and leased | | 27, 184, 857 |
| Average value per acre, $31. | | |
| Value of rigs, wells, engines, boilers, etc | | $55, 936, 194 |
| Value of tanks | | 1, 327, 614 |
| Value of tank cars | | 7, 255 |
| Value of pipe lines at wells owned by parties making report | | 1, 268, 928 |
| Value of oil in stock at wells December 31, 1889 | | 446, 305 |
| Value of other property and improvements | | 3, 390, 855 |
| Total | | 62, 377, 151 |

## LABOR AND WAGES.

The total number of persons reported as employed in the production of crude petroleum in Pennsylvania in 1889 was 19,832, to whom were paid $7,423,781 in wages. The number reported as foremen or overseers was 1,230; as mechanics, 10,049; as laborers, 8,256; as boys under 16 years of age, 156; as employed in offices, males 134, females 7.

While these statistics may correctly represent what they claim to give, namely, the persons actually employed in producing crude petroleum whose wages were paid by the different individuals, firms, or companies producing petroleum, they are misleading, and do not by any means represent the number of persons actually employed in building rigs, drilling wells, and building tankage and pipe lines in the oil regions. A great deal of this work is done by contract, building rigs at so much a rig or so much a foot, in drilling wells at so much a foot, or pumping wells at so much a day or so much a barrel. While the amounts so paid appear in a statement of payments for operating, pumping, and drilling wells, neither the number of men employed nor the amount so paid would appear under the head of wages paid for labor; nor is there any means of arriving at the total number of men so employed or their wages.

The classification of wages, though it is a general one in certain departments of the census, is unfortunate in the petroleum industry, as it is exceedingly difficult to classify the workmen engaged in drilling and operating wells under these classes. A pumper or engineer is neither a foreman. an overseer, a mechanic, nor a laborer, as the term "mechanic" is understood, meaning, as it does in the oil regions, usually a blacksmith, carpenter, or man engaged in a similar occupation. In some instances a pumper, who is the only workman at the well, has been classified as a foreman or overseer.

The division of employés in the table of classified wages given with each district is better than the list following, but as in many instances no return was made in the table of classified wages, the totals of the different employés given in these lists in no case equals the total number of employés given.

The total number of persons employed and the wages paid in the production of crude petroleum in Pennsylvania in 1889, so far as the same have been ascertained, are given in the following tables, by districts:

CLASSES OF LABOR AND WAGES PAID IN PENNSYLVANIA AND NEW YORK OIL FIELDS IN 1889, BY DISTRICTS.

| DISTRICTS. | Total number of employés. | Total wages paid. | FOREMEN OR OVERSEERS. |  | MECHANICS. |  | LABORERS. |  | BOYS UNDER 16 YEARS. |  | OFFICE. |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |  |  |  | Males. |  | Females. |  |
|  |  |  | Number. | Wages. | Number. | Wages. | Number. | Wages. | Number. | Wages. | Number. | Wages. | Number. | Wages. |
| Total | 19,832 | $7,423,781 | 1,230 | $744,674 | 10,049 | $3,742,416 | 8,256 | $2,748,453 | 156 | $53,193 | 134 | $133,741 | 7 | $1,304 |
| Bradford-Allegany | 6,255 | 2,094,342 | 432 | 244,392 | 3,037 | 913,488 | 2,709 | 873,036 | 31 | 6,587 | 45 | 56,479 | 1 | 360 |
| Forest | 191 | 86,799 | 13 | 9,039 | 77 | 33,785 | 99 | 42,850 | ...... | .......... | 2 | 1,125 | ...... | .......... |
| Warren | 2,286 | 864,744 | 120 | 67,276 | 1,256 | 519,476 | 866 | 260,360 | 20 | 6,600 | 24 | 11,032 | ...... | .......... |
| Butler-Clarion-Venango-Armstrong, etc. | 8,386 | 2,639,406 | 492 | 298,692 | 4,164 | 1,214,336 | 3,636 | 1,099,566 | 66 | 16,316 | 22 | 9,552 | 6 | 944 |
| Allegheny | 318 | 210,255 | 17 | 12,613 | 155 | 134,386 | 142 | 61,131 | ...... | .......... | 4 | 2,125 | ...... | .......... |
| Beaver and Smiths Ferry | 354 | 240,994 | 11 | 7,550 | 196 | 175,076 | 147 | 58,368 | ...... | .......... | ...... | .......... | ...... | .......... |
| Washington | 1,557 | 1,019,418 | 117 | 85,356 | 894 | 611,697 | 477 | 254,671 | 39 | 23,690 | 30 | 44,004 | ...... | .......... |
| Greene | 296 | 206,938 | 21 | 15,071 | 177 | 127,335 | 92 | 55,732 | ...... | .......... | 6 | 8,800 | ...... | .......... |
| Franklin | 189 | 60,885 | 7 | 4,685 | 93 | 12,837 | 88 | 42,739 | ...... | .......... | 1 | 624 | ...... | .......... |

EMPLOYMENTS OF LABOR IN PENNSYLVANIA AND NEW YORK OIL FIELDS IN 1889, BY DISTRICTS.

| DISTRICTS. | Total wages paid. | Building rigs. | Drilling wells. | Operating and caring for wells. | Torpedoing or cleaning wells. | Building or repairing tanks. | Building or repairing pipe lines. | Office. |
|---|---|---|---|---|---|---|---|---|
| Total | $7,423,781 | $478,214 | $2,780,795 | $3,773,139 | $105,626 | $110,268 | $40,694 | $135,045 |
| Bradford-Allegany | 2,094,342 | 120,868 | 548,558 | 1,296,607 | 44,153 | 9,286 | 18,031 | 56,839 |
| Forest | 86,799 | 5,015 | 31,849 | 45,547 | 110 | 1,562 | 1,591 | 1,125 |
| Warren | 864,744 | 81,048 | 393,668 | 333,848 | 23,248 | 11,830 | 10,070 | 11,032 |
| Butler-Clarion-Venango-Armstrong, etc | 2,639,406 | 161,908 | 1,097,416 | 1,326,976 | 21,230 | 18,406 | 2,974 | 10,496 |
| Allegheny | 210,255 | 8,919 | 117,977 | 79,565 | .............. | 1,669 | .............. | 2,125 |
| Beaver and Smiths Ferry | 240,994 | 27,696 | 126,409 | 82,989 | .............. | 3,900 | .............. | .............. |
| Washington | 1,019,418 | 66,780 | 373,689 | 464,846 | 12,882 | 52,950 | 4,267 | 44,004 |
| Greene | 206,938 | 3,277 | 75,747 | 101,191 | 3,572 | 10,590 | 3,761 | 8,800 |
| Franklin | 60,885 | 2,703 | 15,482 | 41,570 | 431 | 75 | .............. | 624 |

The division of the $7,423,781 into amounts paid for various purposes shows that $478,214 was paid for labor engaged in building rigs, $2,780,795 in drilling wells, $3,773,139 in operating and caring for wells, $105,626 in torpedoing and cleaning wells, $110,268 in building and repairing tankage at wells, $40,694 in building and repairing pipe lines at wells, and $135,045 in the offices. The only figures that require much comment are those relating to the item of labor paid for drilling wells, which amounted to $2,780,795. This includes not only the amount paid for drilling new wells, but in many instances the cost of drilling and cleaning out old wells. The number of new wells drilled and completed in Pennsylvania and New York in 1889 was 5,435. Where this was done by contract the price ran from 40 cents to $1.50 per foot, the cost of drilling by contract including labor, fuel, wear and tear of tools, and use of machinery and appliances. Possibly 60 cents a foot would represent the cost of drilling a well, of which not much less than 40 cents would be the cost of labor. Assuming that the average depth of wells drilled in Pennsylvania and New York in 1889 was 1,200 feet, this would make the cost of labor per well in round numbers $500, making the total cost of labor in drilling the 5,435 wells drilled in 1889 $2,717,500. A portion of this sum should be added to the $2,780,795 given as the labor cost paid for drilling the same. Relative to drilling by contract, very full information on this subject has been received from Mr. J. L. Wilson, secretary of the Well Drillers' Association, of Titusville, Pennsylvania. Estimating the cost of wells in what is known as the upper district, Mr. Wilson gives the following figures: cost of rig, from $275 to $325; lumber in rig, from 8,000 to 10,000 feet, worth from $8 to $11 per thousand; iron, $70 to $80; timber, besides the lumber mentioned above, $30 to $50; carpenters' work and grading, $75 to $90; carpenters' wages, from $2 to $3.50 per day of 10 hours.

Relative to the cost of machinery, Mr. Wilson states that it is difficult to give exact information, as it is not known just how long machinery will last, its work being divided between drilling and pumping. Drilling machinery rents for drilling purposes, however, at from 10 to 15 cents per foot of drilling done, or from $50 to $75 for 30 days, the machinery including boiler, engine, pipes and fittings, belt, and bull rope. Boilers used in the oil region cost from $275 to $425, engines from $150 to $180, belts from $30 to $50, bull ropes from $15 to $20, and pipes and fittings from $5 to $10.

Drilling costs in the upper region from 40 to 50 cents per foot. This includes cost of labor, fuel, wear and tear of materials, and rent of tools, including ropes, the first cost of tools and rope being from $800 to $1,000. The depth of the new wells of the upper regions is from 600 to 1,000 feet, the time consumed in drilling being from 8 to 15 days of 24 hours each, drilling being continued night and day. The cost of labor is as follows: 2 drillers, at from $3 to $4.50 per day of 12 hours; 2 tool dressers, at from $2.50 to $3.50 per day; fuel, 4 to 5 cents per foot of well drilled, and casing from 30 to 45 cents per foot. The amount used is from 150 to 400 feet. Tubing used, according to depth of well, at from 13 to 17 cents per foot; fittings per well, $12 to $25 ; sucker rods, 5 to 7 cents per foot. The amount of sucker rods used is the same as tubing, varying with the depth of the well. The cost of drilling given above includes putting into the well the casing, tubing, and rods, but not the furnishing of them.

When the well is to be torpedoed, from 20 to 180 quarts of nitroglycerin are used, worth from 90 cents to $1 per quart.

The following is a condensed statement of the labor and wages statistics for the entire states of Pennsylvania and New York in the production of crude petroleum in 1889:

STATISTICS OF LABOR AND WAGES IN THE PENNSYLVANIA AND NEW YORK OIL REGIONS IN 1889.

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of foremen or overseers | 1,230 | |
| Total wages paid all workmen of this class in 1889 | ...... | $744,674 |
| Number of mechanics | 10,049 | |
| Total wages paid all workmen of this class in 1889 | ...... | 3,742,416 |
| Number of laborers | 8,256 | |
| Total wages paid all workmen of this class in 1889 | ...... | 2,748,453 |
| Boys under 16 years | 156 | |
| Total wages paid all boys under 16 years | ...... | 53,193 |
| Office force: | | |
| Total number of males | 134 | |
| Total number of females | 7 | |
| Total wages paid males | ...... | 133,741 |
| Total wages paid females | ...... | 1,304 |
| Total number of persons employed and wages paid in 1889 | 19,832 | 7,423,781 |
| Wages paid for labor: | | |
| In building rigs | | $478,214 |
| In drilling wells | | 2,780,795 |
| In operating and caring for wells | | 3,773,139 |
| In torpedoing wells | | 105,626 |
| In building or repairing tankage | | 110,268 |
| In building and repairing pipe lines | | 40,694 |
| In office | | 135,045 |
| Total | | 7,423,781 |

### BRADFORD-ALLEGANY DISTRICT.

As has already been pointed out, this district lies partly in New York and partly in Pennsylvania, the commercial conditions being such that it is almost impossible to give definitely the proportion of oil produced in each state.

The Allegany portion of the Bradford-Allegany district includes the Richburg and several smaller outlying fields in Allegany county, New York. The area of productive oil territory in this district was estimated in 1885 by the late Dr. Charles A. Ashburner at 31 square miles, of which the Richburg field embraced 28 square miles. At that date Dr. Ashburner estimated that the total production of the district had been about 15,000,000 barrels, or an average of 419,000 barrels per square mile of territory. These figures of production, like nearly all statements published up to within the last 2 years, were based upon statistics contained in Stowell's Petroleum Reporter.

The Bradford portion of the Bradford-Allegany district embraces the oil pools in McKean county, Pennsylvania, and in southern Cattaraugus county, New York. Dr. Ashburner estimated that the area of productive oil territory in this district was 135 square miles and the production at 820,000 barrels per square mile.

The sand and the geological horizon from which this oil is obtained, as well as the character of the oil, are described elsewhere.

The statistics of the production of oil in the Bradford-Allegany district are as follows:

TOTAL PRODUCTION AND VALUE.

| | |
|---|---|
| Total production in 1889 (barrels of 42 gallons) | 7,158,363 |
| Total value at wells of all oil produced, excluding pipage | $6,737,809 |
| Value per barrel | $0.94⅛ |

## STOCKS OF OIL ON HAND AT WELLS.

| | BARRELS. |
|---|---|
| December 31, 1888 | 219,753 |
| December 31, 1889 | 200,824 |

## WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 14,371 |
| Total number of producing wells December 31, 1889 | 16,293 |
| Total number of flowing wells December 31, 1888 | 179 |
| Total number of flowing wells December 31, 1889 | 182 |
| Total number of pumping wells December 31, 1888 | 14,192 |
| Total number of pumping wells December 31, 1889 | 16,111 |
| Number of wells completed in 1889 | 1,034 |
| Number of dry holes in 1889 | 81 |
| Number of producing wells completed in 1889 | 953 |
| Initial daily production of new wells (barrels) | 6,863 |
| Number of rigs building December 31, 1888 | 15 |
| Number of rigs building December 31, 1889 | 96 |
| Number of wells drilling December 31, 1888 | 29 |
| Number of wells drilling December 31, 1889 | 148 |
| Value of material used in caring for and operating wells in 1889 | $2,603,248 |

## CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $32,288,195 |
| Number of acres of oil land: | | |
| Owned | 90,515 | |
| Leased | 92,346 | |
| Total acreage | 182,861 | |
| Present value of land, both owned and leased | | 8,562,827 |
| Average value per acre, $47. | | |
| Value of rigs, wells, engines, boilers, etc | | $20,149,046 |
| Value of tanks | | 534,594 |
| Value of tank cars | | 510 |
| Value of pipe lines at wells owned by parties making report | | 681,549 |
| Value of oil in stock at wells December 31, 1889 | | 181,376 |
| Value of other property and improvements | | 2,178,293 |
| Total | | 23,725,368 |

## LABOR AND WAGES.

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of foremen or overseers | 432 | |
| Total wages paid all workmen of this class in 1889 | ..... | $244,392 |
| Number of mechanics | 3,037 | |
| Total wages paid all workmen of this class in 1889 | ..... | 913,488 |
| Number of laborers | 2,709 | |
| Total wages paid all workmen of this class in 1889 | ..... | 873,036 |
| Boys under 16 years | 31 | |
| Total wages paid all boys under 16 years | ..... | 6,587 |
| Office force: | | |
| Total number of males | 45 | |
| Total number of females | 1 | |
| Total wages paid males | ..... | 56,479 |
| Total wages paid females | ..... | 360 |
| Total number of persons employed and wages paid in 1889 | 6,255 | 2,094,342 |

| | |
|---|---|
| Wages paid for labor: | |
| In building rigs | $120,868 |
| In drilling wells | 548,558 |
| In operating and caring for wells | 1,296,607 |
| In torpedoing wells | 44,153 |
| In building or repairing tankage | 9,286 |
| In building and repairing pipe lines | 18,031 |
| In office | 56,839 |
| Total | 2,094,342 |

### CLASSIFIED WAGES.

| CLASS OF LABOR. | Number of each class. | Range of wages. |
|---|---|---|
| Foremen | 207 | $100 to $133 per month. |
| Pumpers or engineers | 2, 209 | $5 to $85 per month. |
| Carpenters | 687 | $2 to $3.50 per day. |
| Rig builders | 601 | $50 to $190 per rig.<br>$2.50 to $3 per day. |
| Drillers | 1, 061 | 40 cents to $1 per foot.<br>$3.50 to $4 per day. |
| Tool dressers | 22 | $2.50 to $3 per day. |
| Laborers | 882 | $1.25 to $2.50 per day. |
| Teamsters | 52 | $50 to $125 per month. |
| Boys under 16 years | 8 | $1 to $1.50 per day. |
| Well cleaners | 334 | $4 to $6.25 per day. |
| Sundry mechanics | 69 | $50 per month.<br>$2.50 to $4 per day. |

## FOREST COUNTY DISTRICT, PENNSYLVANIA.

The Forest county district is that portion of what is known as the Middle field embraced in the county of Forest. Part of these pools lie in Forest county and part in Warren county. They are small in area, the entire Forest county field, including that in Warren county, covering an area of about 9 square miles. The sand has somewhat the general appearance of the Bradford sand, but is coarser grained, and contains small pebbles. The Cooper third sand is found at the depth of 1,850 feet, and is supposed to occupy the same geological horizon as the Bradford and Allegany and to be of the Chemung.

The statistics of the production of petroleum in Forest county district are as follows:

### TOTAL PRODUCTION AND VALUE.

| | |
|---|---|
| Total production in 1889 (barrels of 42 gallons) | 258, 955 |
| Total value at wells of all oil produced, excluding pipage | $295, 532 |
| Value per barrel | $1. 14⅛ |

### STOCKS OF OIL ON HAND AT WELLS.

| | BARRELS. |
|---|---|
| December 31, 1888 | 5, 531 |
| December 31, 1889 | 6, 801 |

### WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 240 |
| Total number of producing wells December 31, 1889 | 299 |
| Total number of flowing wells December 31, 1888 | 84 |
| Total number of flowing wells December 31, 1889 | 67 |
| Total number of pumping wells December 31, 1888 | 156 |
| Total number of pumping wells December 31, 1889 | 232 |
| Number of wells completed in 1889 | 55 |
| Number of dry holes in 1889 | 9 |
| Number of producing wells completed in 1889 | 46 |
| Initial daily production of new wells (barrels) | 478 |
| Number of rigs building December 31, 1888 | 3 |
| Number of rigs building December 31, 1889 | 2 |
| Number of wells drilling December 31, 1888 | 3 |
| Number of wells drilling December 31, 1889 | 10 |
| Value of materials used in pumping, operating, and caring for wells in 1889 | $29, 900 |

### CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $1,162,174 |
| Number of acres of oil land: | | |
| Owned | 12,194 | |
| Leased | 18,701 | |
| Total acreage | 30,895 | |
| Present value of land, both owned and leased | | 648,338 |
| Average value per acre, $21. | | |
| Value of rigs, wells, engines, boilers, etc | | $406,559 |
| Value of tanks | | 15,911 |
| Value of tank cars | | 495 |
| Value of pipe lines at wells owned by parties making report | | 42,755 |
| Value of oil in stock at wells December 31, 1889 | | 7,668 |
| Value of other property and improvements | | 40,448 |
| Total | | 513,836 |

### LABOR AND WAGES.

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of foremen or overseers | 13 | |
| Total wages paid all workmen of this class in 1889 | | $9,039 |
| Number of mechanics | 77 | |
| Total wages paid all workmen of this class in 1889 | | 33,785 |
| Number of laborers | 99 | |
| Total wages paid all workmen of this class in 1889 | | 42,850 |
| Office force: | | |
| Total number (males) | 2 | |
| Total wages paid (males) | | 1,125 |
| Total number of persons employed and wages paid in 1889 | 191 | 86,799 |

| | |
|---|---|
| Wages paid for labor: | |
| In building rigs | $5,015 |
| In drilling wells | 31,849 |
| In operating and caring for wells | 45,547 |
| In torpedoing wells | 110 |
| In building or repairing tankage | 1,562 |
| In building and repairing pipe lines | 1,591 |
| In office | 1,125 |
| Total | 86,799 |

### CLASSIFIED WAGES.

| CLASS OF LABOR. | Number of each class. | Range of wages. |
|---|---|---|
| Foremen | 9 | $50 to $100 per month. |
| Pumpers or engineers | 57 | $20 to $60 per month. |
| Carpenters | 10 | $2 to $3.50 per day. |
| Rig builders | 25 | $62.75 to $125 per rig. |
| Drillers | 50 | 40 to 60 cents per foot. |
| Tool dressers | 5 | $3 to $3.50 per day. |
| Laborers | 22 | $1.50 to $2.50 per day. |
| Teamsters | 7 | $5 per day. |
| Well cleaners | 2 | $5 per day. |
| Sundry mechanics | 1 | $60 per month. |

### WARREN COUNTY.

The Warren county portion of the Warren district includes the oil pools in eastern Warren county, of which the largest is the Clarendon, and also the Warren county portion of the Cooper and Sheffield fields, which lie partly in Warren and partly in Forest counties. The depths of the Warren district oil sands, according to Mr. Carll, are as follows: the North Warren sand, 1,100 feet; the third Warren sand, 1,300 feet; the Clarendon fourth sand, 1,450 feet; the Cherry Grove third sand, 1,625 feet. As stated before, the oils from the Warren pools vary greatly in color and gravity. They are, however, generally spoken of as amber oils.

The statistics of the production of petroleum in Warren county in 1889 are as follows:

### TOTAL PRODUCTION AND VALUE.

| | |
|---|---|
| Total production in 1889 (barrels of 42 gallons) | 2, 347, 434 |
| Total value at wells of all oil produced, excluding pipage | $2, 679, 010 |
| Value per barrel | $1. 14⅛ |

### STOCKS OF OIL ON HAND AT WELLS.

| | BARRELS. |
|---|---|
| December 31, 1888 | 36, 972 |
| December 31, 1889 | 53, 292 |

### WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 2, 880 |
| Total number of producing wells December 31, 1889 | 4, 178 |
| Total number of flowing wells December 31, 1888 | 790 |
| Total number of flowing wells December 31, 1889 | 1, 586 |
| Total number of pumping wells December 31, 1888 | 2, 090 |
| Total number of pumping wells December 31, 1889 | 2, 592 |
| Number of wells completed in 1889 | 636 |
| Number of dry holes in 1889 | 40 |
| Number of producing wells completed in 1889 | 596 |
| Initial daily production of new wells (barrels) | 3, 210 |
| Number of rigs building December 31, 1888 | 19 |
| Number of rigs building December 31, 1889 | 27 |
| Number of wells drilling December 31, 1888 | 20 |
| Number of wells drilling December 31, 1889 | 45 |
| Value of materials used in pumping, operating, and caring for wells in 1889 | $1, 022, 966 |

### CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $10, 680, 618 |
| Number of acres of oil land: | | |
| Owned | 33, 744 | |
| Leased | 54, 742 | |
| Total acreage | 88, 486 | |
| Present value of land, both owned and leased | | 3, 971, 524 |
| Average value per acre, $45. | | |
| Value of rigs, wells, engines, boilers, etc | | $5, 575, 578 |
| Value of tanks | | 160, 376 |
| Value of pipe lines at wells owned by parties making report | | 215, 212 |
| Value of oil in stock at wells December 31, 1889 | | 60, 820 |
| Value of other property and improvements | | 697, 108 |
| Total | | 6, 709, 094 |

### LABOR AND WAGES.

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of foremen or overseers | 120 | |
| Total wages paid all workmen of this class in 1889 | ..... | $67, 276 |
| Number of mechanics | 1, 256 | |
| Total wages paid all workmen of this class in 1889 | ..... | 519, 476 |
| Number of laborers | 866 | |
| Total wages paid all workmen of this class in 1889 | ..... | 260, 360 |
| Boys under 16 years | 20 | |
| Total wages paid all boys under 16 years | ..... | 6, 600 |
| Office force: | | |
| Total number (males) | 24 | |
| Total wages paid (males) | ..... | 11, 032 |
| Total number of persons employed and wages paid in 1889 | 2, 286 | 864, 744 |

| | |
|---|---|
| Wages paid for labor: | |
| In building rigs | $81, 048 |
| In drilling wells | 393, 668 |
| In operating and caring for wells | 333, 848 |
| In torpedoing wells | 23, 248 |
| In building or repairing tankage | 11, 830 |
| In building and repairing pipe lines | 10, 070 |
| In office | 11, 032 |
| Total | 864, 744 |

### CLASSIFIED WAGES.

| CLASS OF LABOR. | Number of each class. | Range of wages. |
|---|---|---|
| Foremen | 62 | $40 to $100 per month. |
| Pumpers or engineers | 442 | $10 to $75 per month. |
| Carpenters | 204 | $2.50 to $3.25 per day. |
| Rig builders | 302 | $65 to $200 per rig. |
| Drillers | 616 | $40 to $90 per month. |
| Tool dressers | 34 | $3 to $3.50 per day. |
| Laborers | 444 | $1.50 to $2 per day. |
| Teamsters | 86 | $1.50 to $5 per day. |
| Well cleaners | 84 | $5 per day. |
| Sundry mechanics | 20 | $1.70 to $3.50 per day. |

## THE BUTLER-CLARION-VENANGO DISTRICT.

In this district are included the wells usually classified under 2 districts, the Butler-Armstrong and the Venango-Clarion. None of the wells producing lubricating oil in what is generally called the Franklin district of Venango county, however, are included in this district. The oils of this district all come from the same group of oil sands, there being 3 principal sand rocks. The first sand, which is the uppermost of the 3, lies about 450 feet below the base of the Olean conglomerate. They are all contained within an interval of 350 feet, and are believed to belong to the Catskill formation. They generally consist of white, gray, or yellow pebble rock. The oils are generally green and, in some instances, amber. The average gravity of the oil from the third sand, which is the greatest producer, is about 48°.

Dr. Ashburner estimated the total area of the Venango district as 65 square miles, and that of the Butler district as 76 square miles.

The statistics of the production of petroleum in the Butler-Clarion-Venango district are as follows:

### TOTAL PRODUCTION AND VALUE.

| | |
|---|---|
| Total production in 1889 (barrels of 42 gallons) | 6,243,522 |
| Total value at wells of all oil produced, excluding pipage | $7,125,421 |
| Value per barrel | $1.14⅛ |

### STOCKS OF ILLUMINATING OIL ON HAND AT WELLS.

| | BARRELS. |
|---|---|
| December 31, 1888 | 34,406 |
| December 31, 1889 | 60,262 |

### WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 6,138 |
| Total number of producing wells December 31, 1889 | 8,336 |
| Total number of flowing wells December 31, 1888 | 28 |
| Total number of flowing wells December 31, 1889 | 308 |
| Total number of pumping wells December 31, 1888 | 6,110 |
| Total number of pumping wells December 31, 1889 | 8,028 |
| Number of wells completed in 1889 | 2,685 |
| Number of dry holes in 1889 | 546 |
| Number of producing wells completed in 1889 | 2,139 |
| Initial daily production of new wells (barrels) | 22,813 |
| Number of rigs building December 31, 1888 | 83 |
| Number of rigs building December 31, 1889 | 213 |
| Number of wells drilling December 31, 1888 | 136 |
| Number of wells drilling December 31, 1889 | 231 |
| Value of materials used in caring for and operating wells in 1889 | $1,787,296 |

## CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $26,020,574 |
| Number of acres of oil land: | | |
| Owned | 142,634 | |
| Leased | 208,644 | |
| Total acreage | 351,278 | |
| Present value of land, both owned and leased | | 8,322,204 |
| Average value per acre, $24. | | |
| Value of rigs, wells, engines, boilers, etc | | $16,654,912 |
| Value of tanks | | 421,192 |
| Value of tank cars | | 5,250 |
| Value of pipe lines at wells owned by parties making report | | 233,300 |
| Value of oil in stock at wells December 31, 1889 | | 70,676 |
| Value of other property and improvements | | 313,040 |
| Total | | 17,698,370 |

## LABOR AND WAGES.

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of foremen or overseers | 492 | |
| Total wages paid all workmen of this class in 1889 | ..... | $298,692 |
| Number of mechanics | 4,164 | |
| Total wages paid all workmen of this class in 1889 | ..... | 1,214,336 |
| Number of laborers | 3,636 | |
| Total wages paid all workmen of this class in 1889 | ..... | 1,099,566 |
| Boys under 16 years | 66 | |
| Total wages paid all boys under 16 years | ..... | 16,316 |
| Office force: | | |
| Total number of males | 22 | |
| Total number of females | 6 | |
| Total wages paid males | ..... | 9,552 |
| Total wages paid females | ..... | 944 |
| Total number of persons employed and wages paid in 1889 | 8,386 | 2,639,406 |

| | | |
|---|---|---|
| Wages paid for labor: | | |
| In building rigs | ..... | $161,908 |
| In drilling wells | | 1,097,416 |
| In operating and caring for wells | | 1,326,976 |
| In torpedoing wells | | 21,230 |
| In building or repairing tankage | | 18,406 |
| In building and repairing pipe lines | | 2,974 |
| In office | | 10,496 |
| Total | | 2,639,406 |

## CLASSIFIED WAGES.

| CLASS OF LABOR. | Number of each class. | Range of wages. |
|---|---|---|
| Foremen | 134 | $20 to $100 per month. |
| Pumpers or engineers | 2,538 | $30 to $85 per month. |
| Carpenters | 286 | $1.25 to $3 per day. |
| Rig builders | 1,234 | $50 to $200 per rig. |
| Drillers | 2,474 | 35 cents to $1 per foot. |
| Tool dressers | 32 | $2.50 to $3 per day. |
| Laborers | 818 | $1 to $2.50 per day. |
| Teamsters | 110 | $2.50 to $5 per day. |
| Boys under 16 years | 18 | $10 to $20 per month. |
| Well cleaners | 274 | $2.50 to $5 per day. |
| Sundry mechanics | 74 | $1.25 to $4 per day. |

### ALLEGHENY COUNTY.

The oil produced in Allegheny county is from several districts, among them being Shannopin and Brush Creek. The Shannopin oil field, which came into prominence in February, 1886, derives its oil from the lower part of the Venango oil group, which in this locality seems to be spotted or unreliable, as was shown in the early operations in this field by the large proportion of dry holes to productive wells. In June, 1886, 46 wells were drilled, of which 26 were dry; in October 97 wells were drilled, of which 42 were dry, and in December 132 wells were drilled, of which 48 were dry. The remarks regarding the Shannopin field will apply to the other districts in the Allegheny valley.

The statistics of the production of petroleum in Allegheny county in 1889 are as follows:

#### TOTAL PRODUCTION AND VALUE.

| | |
|---|---|
| Total production in 1889 (barrels of 42 gallons) | 541,092 |
| Total value at wells of all oil produced, excluding pipage | $617,512 |
| Value per barrel | $1.14⅛ |

#### STOCKS OF ILLUMINATING OIL ON HAND AT WELLS.

| | BARRELS. |
|---|---|
| December 31, 1888 | 2,378 |
| December 31, 1889 | 7,111 |

#### WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 176 |
| Total number of producing wells December 31, 1889 | 298 |
| Total number of flowing wells December 31, 1888 | 160 |
| Total number of flowing wells December 31, 1889 | 36 |
| Total number of pumping wells December 31, 1888 | 16 |
| Total number of pumping wells December 31, 1889 | 262 |
| Number of wells completed in 1889 | 231 |
| Number of dry holes in 1889 | 73 |
| Number of producing wells completed in 1889 | 158 |
| Initial daily production of new wells (barrels) | 6,223 |
| Number of rigs building December 31, 1888 | 17 |
| Number of rigs building December 31, 1889 | 5 |
| Number of wells drilling December 31, 1888 | 24 |
| Number of wells drilling December 31, 1889 | 19 |
| Value of materials used in caring for and operating wells in 1889 | $215,096 |

#### CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $2,070,926 |
| Number of acres of oil land: | | |
| Owned | 2,407 | |
| Leased | 29,564 | |
| Total acreage | 31,971 | |
| Present value of land, both owned and leased | | 739,876 |
| Average value per acre, $23. | | |
| Value of rigs, wells, engines, boilers, etc | | $1,280,455 |
| Value of tanks | | 10,900 |
| Value of pipe lines at wells owned by parties making report | | 4,771 |
| Value of oil in stock at wells December 31, 1889 | | 6,857 |
| Value of other property and improvements | | 28,067 |
| Total | | 1,331,050 |

### LABOR AND WAGES.

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of foremen or overseers | 17 | |
| Total wages paid all workmen of this class in 1889 | .... | $12,613 |
| Number of mechanics | 155 | |
| Total wages paid all workmen of this class in 1889 | .... | 134,386 |
| Number of laborers | 142 | |
| Total wages paid all workmen of this class in 1889 | .... | 61,131 |
| Office force: | | |
| Total number (males) | 4 | |
| Total wages paid (males) | .... | 2,125 |
| Total number of persons employed and wages paid in 1889 | 318 | 210,255 |

| | |
|---|---|
| ages paid for labor: | |
| In building rigs | $8,919 |
| In drilling wells | 117,977 |
| In operating and caring for wells | 79,565 |
| In building or repairing tankage | 1,669 |
| In office | 2,125 |
| Total | 210,255 |

### CLASSIFIED WAGES.

| CLASS OF LABOR. | Number of each class. | Range of wages. |
|---|---|---|
| Foremen | 17 | $45 to $100 per month. |
| Pumpers or engineers | 144 | $20 to $65 per month. |
| Carpenters | 10 | $2.50 per day. |
| Rig builders | 46 | $100 to $180 per rig. |
| Drillers | 85 | 50 cents to $1.15 per foot. |
| Laborers | 6 | $50 to $60 per month. |
| Well cleaners | 2 | $2.50 to $3.50 per day. |

## BEAVER COUNTY.

Under Beaver county in the table of production of crude petroleum in 1889 is included all of the oil produced in that county except that produced in the Smiths Ferry district, which is reported by itself. The production in Beaver county proper, which includes all that produced in the Brush Creek and Shannopin districts, in Beaver county, and all other districts except Smiths Ferry, was 602,736 barrels. The production of Smiths Ferry, a small amount of which came from wells in Ohio, was 29,000 barrels, making a total in Beaver county of 631,736 barrels. The ordinary Beaver county oil was worth on an average $1.19⅛ per barrel, 25 cents above the price of pipe-line certificates. The Smiths Ferry oil was worth about the same.

The only district calling for any particular description is that known as the Smiths Ferry. This district lies principally in Beaver county, north of the Ohio river and east of Beaver creek. About one-fourth of the total production is furnished by wells along Island run, located in Columbiana county, Ohio. The territory covered by this district is about 4 miles square, containing about 2,500 acres. During 1889 there were 25 companies, firms, or individuals who owned or operated a total of 84 producing wells in this district. The entire production was 29,000 barrels of 42 gallons each, about one-third of which went directly to refineries situated at Smiths Ferry. This oil is carried to the refineries by tank wagons, the wells being from 2.5 to 4 miles from them. The refiners find difficulty in securing a regular supply of oil, as the deliveries are dependent upon the condition of the roads. The wells in this district are from 700 to 1,300 feet deep, are small producers, but promise to continue as producers for many years. The product is a heavy amber-colored oil, very desirable for lubricating purposes, and finds a regular market. Of the 25 operators in this district all but 10 cared for and pumped their own wells. Most of the wells are pumped by heads, few being pumped continuously. Rigs cost from $300 to $350 each. The cost of drilling is from 70 to 75 cents per foot.

The statistics of the production of petroleum in the Beaver county district in 1889 are as follows:

### PRODUCTION OF OIL IN 1889.

| | BARRELS. |
|---|---|
| Illuminating | 602,736 |
| Lubricating | 29,000 |
| Total | 631,736 |

## VALUE AT WELLS OF ALL OIL PRODUCED, EXCLUDING PIPAGE.

| KINDS OF OIL. | Value. | Value per barrel. |
|---|---|---|
| Total | $752, 556 | $1. 19⅛ |
| Illuminating | 718, 010 | 1. 19⅛ |
| Lubricating | 34, 546 | 1. 19⅛ |

## STOCKS OF OIL ON HAND AT WELLS.

| | BARRELS. |
|---|---|
| December 31, 1888: | |
| Illuminating | 6, 106 |
| Lubricating | 642 |
| Total | 6, 748 |
| December 31, 1889: | |
| Illuminating | 14, 910 |
| Lubricating | 703 |
| Total | 15, 613 |

## WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 199 |
| Total number of producing wells December 31, 1889 | 270 |
| Total number of flowing wells December 31, 1888 | 3 |
| Total number of flowing wells December 31, 1889 | 14 |
| Total number of pumping wells December 31, 1888 | 196 |
| Total number of pumping wells December 31, 1889 | 256 |
| Number of wells completed in 1889 | 83 |
| Number of dry holes in 1889 | 13 |
| Number of producing wells completed in 1889 | 70 |
| Initial daily production of new wells (barrels) | 2, 572 |
| Number of rigs building December 31, 1889 | 5 |
| Number of wells drilling December 31, 1889 | 4 |
| Value of materials used in caring for and operating wells in 1889 | $214, 026 |

## CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $2, 203, 219 |
| Number of acres of oil land: | | |
| Owned | 981 | |
| Leased | 27, 831 | |
| Total acreage | 28, 812 | |
| Present value of land, both owned and leased | | 998, 055 |
| Average value per acre, $35. | | |
| Value of rigs, wells, engines, boilers, etc | | $1, 134, 572 |
| Value of tanks | | 21, 046 |
| Value of pipe lines at wells owned by parties making report | | 2, 632 |
| Value of oil in stock at wells December 31, 1889 | | 18, 904 |
| Value of other property and improvements | | 28, 010 |
| Total | | 1, 205, 164 |

## LABOR AND WAGES.

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of foremen or overseers | 11 | |
| Total wages paid all workmen of this class in 1889 | | $7, 550 |
| Number of mechanics | 196 | |
| Total wages paid all workmen of this class in 1889 | .... | 175, 076 |
| Number of laborers | 147 | |
| Total wages paid all workmen of this class in 1889 | .... | 58, 368 |
| Total number of persons employed and wages paid in 1889 | 354 | 240, 994 |

| | |
|---|---|
| Wages paid for labor: | |
| In building rigs | $27, 696 |
| In drilling wells | 126, 409 |
| In operating and caring for wells | 82, 989 |
| In building or repairing tankage | 3, 900 |
| Total | 240, 994 |

### CLASSIFIED WAGES.

| CLASS OF LABOR. | Number of each class. | Range of wages. |
|---|---|---|
| Foremen | 9 | $50 to $150 per month. |
| Pumpers or engineers | 81 | $8.33⅓ to $70 per month. |
| Carpenters | 13 | $2.50 per day. |
| Rig builders | 42 | $110 to $225.50 per rig. |
| Drillers | 84 | $70 to $90 per month. |
| Laborers | 35 | $1.39 to $2 per day. |
| Teamsters | 1 | ½ cent per gallon. |
| Sundry mechanics | 18 | $61.39 per month. |

## WASHINGTON COUNTY.

The interest in drilling operations in Washington county began in 1885 with the drilling of the Gantz well by the Citizens' Fuel Company of Washington, Pennsylvania. It was drilled for the purpose of obtaining natural gas. At a depth of 2,200 feet a small showing of oil was found, and the hopes of the proprietors turned from gas to oil. After two small flows, one in January and the other in February, 1885, they were compelled to accept the fact that the well was only a pumper. Matters remained in abeyance until August, 1885, when with the drilling in of the Gordon gusher, drilled by the owners of the Gantz well, attention was once more attracted to this field and drilling again began. The total production of Washington county in 1885 was only some 10,500 barrels. In 1886 the interest in petroleum in Pennsylvania centered in this district.

The importance of the Washington field as a producer of petroleum really began in March, 1886. On the 11th of that month the Pew and Emerson Manifold well came in as a heavy producer, and in April the Thayer well followed with 2,000 barrels daily production, and a field of "gushers" was opened. The production reached 4,000 barrels daily at the close of May. In June it had risen to 10,120 barrels a day, and during October a production of 17,549 barrels a day was reached. This heavy yield was not maintained for any length of time, the output of the field at the close of 1886 being only about 10,000 barrels a day. The total production of the Washington field in 1886 was 3,189,822 barrels. In 1887 this had fallen to 2,859,344 barrels. In 1888 it still further declined to 2,322,190 barrels. There was somewhat of an increase in 1889, the production being 3,848,145 barrels, but at the close of 1889 the field continued to decrease in production, many wells having fallen off to such an extent that abandonment was seriously considered. The character of this oil and the horizon in which it is found have been discussed so thoroughly in other parts of this report that they need not be repeated in detail here, it being deemed sufficient to add that the principal part of the oil in the Washington district comes from the Gantz sand and the 50-foot rock lying in the horizon of the first sand of the Venango oil group. Large wells have also been obtained in the Gordon sand, lying near the bottom of the group, as well as in the basal rocks of the carboniferous series above the oil group.

The statistics of the production of petroleum in 1889 in the Washington district are as follows:

### TOTAL PRODUCTION AND VALUE.

| | |
|---|---|
| Total production in 1889 (barrels of 42 gallons) | 3,848,145 |
| Total value at wells of all oil produced, excluding pipage | $4,584,103 |
| Value per barrel | $1.19⅛ |

### STOCKS OF OIL ON HAND AT WELLS.

| | BARRELS. |
|---|---|
| December 31, 1888 | 33,078 |
| December 31, 1889 | 78,761 |

### WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 618 |
| Total number of producing wells December 31, 1889 | 1,232 |
| Total number of flowing wells December 31, 1888 | 108 |
| Total number of flowing wells December 31, 1889 | 186 |
| Total number of pumping wells December 31, 1888 | 510 |
| Total number of pumping wells December 31, 1889 | 1,046 |
| Number of wells completed in 1889 | 577 |
| Number of dry holes in 1889 | 66 |
| Number of producing wells completed in 1889 | 511 |
| Initial daily production of new wells (barrels) | 26,297 |
| Number of rigs building December 31, 1888 | 33 |
| Number of rigs building December 31, 1889 | 60 |
| Number of wells drilling December 31, 1888 | 42 |
| Number of wells drilling December 31, 1889 | 132 |
| Value of materials used in pumping, caring for, and operating wells in 1889 | $2,454,446 |

### CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $12,238,107 |
| Number of acres of oil land: | | |
| Owned | 2,544 | |
| Leased | 109,593 | |
| Total acreage | 112,137 | |
| Present value of land, both owned and leased | | 2,703,816 |
| Average value per acre, $24. | | |
| Value of rigs, wells, engines, boilers, etc | | $9,151,407 |
| Value of tanks | | 139,590 |
| Value of pipe lines at wells owned by parties making report | | 81,819 |
| Value of oil in stock at wells December 31, 1889 | | 99,054 |
| Value of other property and improvements | | 62,421 |
| Total | | 9,534,291 |

### LABOR AND WAGES.

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of foremen or overseers | 117 | |
| Total wages paid all workmen of this class in 1889 | | $85,356 |
| Number of mechanics | 894 | |
| Total wages paid all workmen of this class in 1889 | | 611,697 |
| Number of laborers | 477 | |
| Total wages paid all workmen of this class in 1889 | | 254,671 |
| Number of boys under 16 years | 39 | |
| Total wages paid to all boys in 1889 | | 23,690 |
| Office force: | | |
| Total number (males) | 30 | |
| Total wages paid (males) | | 44,004 |
| Total number of persons employed and wages paid in 1889 | 1,557 | 1,019,418 |

| | |
|---|---|
| Wages paid for labor: | |
| In building rigs | $66,780 |
| In drilling wells | 373,689 |
| In operating and caring for wells | 464,846 |
| In torpedoing wells | 12,882 |
| In building or repairing tankage | 52,950 |
| In building and repairing pipe lines | 4,267 |
| In office | 44,004 |
| Total | 1,019,418 |

### CLASSIFIED WAGES.

| CLASS OF LABOR. | Number of each class. | Range of wages. |
|---|---|---|
| Foremen | 90 | $80 to $125 per month. |
| Pumpers or engineers | 610 | $15 to $60 per month. |
| Carpenters | 30 | $2.50 to $3 per day. |
| Rig builders | 198 | $150 to $200 per rig. |
| Drillers | 588 | $1 to $1.50 per foot. |
| Tool dressers | 6 | $5 per day. |
| Laborers | 252 | $1.25 to $2.50 per day. |
| Well cleaners | 36 | $2 to $5 per day. |
| Sundry mechanics | 21 | $50 to $60 per month. |

### GREENE COUNTY.

The first wells drilled in Greene county, on Dunkard creek, were begun in 1865, operations being quite extensive. In their character the wells were shallow, and but few produced largely. The more recent developments have been deeper. The oil obtained in these sands has been much more abundant than that found in the early operations. The general character of the developments here are similar to those in Washington, of which they are practically extensions.

The statistics of the production of petroleum in Greene county in 1889 are as follows:

### TOTAL PRODUCTION AND VALUE.

| | |
|---|---|
| Total production in 1889 (barrels of 42 gallons) | 392, 912 |
| Total value at wells of all oil produced, excluding pipage | $468, 056 |
| Value per barrel | $1. 19⅛ |

### STOCKS OF OIL ON HAND AT WELLS.

| | BARRELS. |
|---|---|
| December 31, 1888 | 321 |
| December 31, 1889 | 672 |

### WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 193 |
| Total number of producing wells December 31, 1889 | 231 |
| Total number of flowing wells December 31, 1888 | 6 |
| Total number of flowing wells December 31, 1889 | 19 |
| Total number of pumping wells December 31, 1888 | 187 |
| Total number of pumping wells December 31, 1889 | 212 |
| Number of wells completed in 1889 | 98 |
| Number of dry holes in 1889 | 47 |
| Number of producing wells completed in 1889 | 51 |
| Initial daily production of new wells (barrels) | 2, 745 |
| Number of rigs building December 31, 1888 | 5 |
| Number of rigs building December 31, 1889 | 14 |
| Number of wells drilling December 31, 1888 | 17 |
| Number of wells drilling December 31, 1889 | 21 |
| Value of materials used in caring for and operating wells in 1889 | $274, 460 |

### CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $2, 171, 763 |
| Number of acres of oil land: | | |
| Owned | 275 | |
| Leased | 41, 808 | |
| Total acreage | 42, 083 | |
| Present value of land, both owned and leased | | 978, 427 |
| Average value per acre, $23. | | |
| Value of rigs, wells, engines, boilers, etc | | $1, 148, 224 |
| Value of tanks | | 13, 750 |
| Value of pipe lines at wells owned by parties making report | | 2, 762 |
| Value of oil in stock at wells December 31, 1889 | | 950 |
| Value of other property and improvements | | 27, 650 |
| Total | | 1, 193, 336 |

### LABOR AND WAGES.

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of foremen or overseers | 21 | |
| Total wages paid all workmen of this class in 1889 | .... | $15, 071 |
| Number of mechanics | 177 | |
| Total wages paid all workmen of this class in 1889 | .... | 127, 335 |
| Number of laborers | 92 | |
| Total wages paid all workmen of this class in 1889 | .... | 55, 732 |
| Office force: | | |
| Total number (males) | 6 | |
| Total wages paid (males) | .... | 8, 800 |
| Total number of persons employed and wages paid in 1889 | 296 | 206. 938 |

| | |
|---|---|
| Wages paid for labor: | |
| In building rigs | $3, 277 |
| In drilling wells | 75, 747 |
| In operating and caring for wells | 101, 191 |
| In torpedoing wells | 3, 572 |
| In building or repairing tankage | 10, 590 |
| In building and repairing pipe lines | 3, 761 |
| In office | 8, 800 |
| Total | 206, 938 |

### THE FRANKLIN DISTRICT.

Under this head is included only the lubricating oil from the neighborhood of Franklin, Pennsylvania. This oil is entirely a lubricating oil, and is produced chiefly if not entirely from the first oil sand. It is noticeable that this lubricating oil, which is of a dark brownish-green color and of 32° gravity (31° to 33° being the range), comes from the same sand as a greenish-black oil of 46° gravity produced in Warren county, a dark amber oil of 47.5° gravity produced between Titusville and Pleasantville, and the light-amber oil of 52° gravity produced in Washington county. The thickness of this sand at Franklin is about 35 feet. 3 grades of these oils are produced, known respectively as Old District oil, No. 1, and No. 2. The production of these several grades of oil in 1889 was as follows: Old District oil, 49,879 barrels, worth $3.65 per barrel; No. 1, 11,088 barrels, worth $2.50 per barrel, and No. 2, 4,309 barrels, worth $1.25 per barrel, making a total production of 65,276 barrels, worth $215,164.

The product in the heavy-oil district has greatly diminished, and but little new production is being developed in newly drilled territory. The wells, however, seem to be long-lived. Mr. E. W. Shippen writes that the first well drilled on his property was in February, 1865. It produced 180 barrels of oil in 3 days, being worth $30 a barrel at the well at that time. It has produced oil, but in diminished quantities, ever since. In 1883 the production was about 1 barrel a day. It now produces only about one-third of a barrel a day. Mr. Shippen also states that in February and March, 1862, he loaded petroleum on the bark Katharine in Philadelphia, which he believes to be the first full cargo ever shipped from this country to London, and it overstocked the market.

The statistics of the production of petroleum in the Franklin district in 1889 are as follows:

#### TOTAL PRODUCTION AND VALUE.

| | |
|---|---|
| Total production in 1889 (barrels of 42 gallons) | 65, 276 |
| Total value at wells of all oil produced, excluding pipage | $215, 164 |
| Value per barrel | $3. 30 |

But very little oil is carried over at the wells.

| GRADES OF OIL. | Production. (Barrels.) | Value per barrel. | Total value. |
|---|---|---|---|
| Total | 65, 276 | $3. 30 | $215, 164 |
| Old District | 49, 879 | 3. 65 | 182, 058 |
| No. 1 | 11, 088 | 2. 50 | 27, 720 |
| No. 2 | 4, 309 | 1. 25 | 5, 386 |

#### WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 605 |
| Total number of producing wells December 31, 1889 | 631 |
| Total number of pumping wells December 31, 1888 | 605 |
| Total number of pumping wells December 31, 1889 | 631 |
| Number of wells completed in 1889 | 36 |
| Number of producing wells completed in 1889 | 36 |
| Initial daily production of new wells (barrels) | 122 |
| Number of rigs building December 31, 1888 | 4 |
| Number of wells drilling December 31, 1888 | 2 |
| Value of materials used in pumping, caring for, and operating wells in 1889 | $31, 953 |

#### CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $726, 432 |
| Number of acres of oil land: | | |
| Owned | 3, 216 | |
| Leased | 1, 660 | |
| Total acreage | 4, 876 | |
| Present value of land, both owned and leased | | 259, 790 |
| Average value per acre, $53. | | |
| Value of rigs, wells, engines, boilers, etc | | $435, 441 |
| Value of tanks | | 10, 255 |
| Value of tank cars | | 1, 000 |
| Value of pipe lines at wells owned by parties making report | | 4, 128 |
| Value of other property and improvements | | 15, 818 |
| Total | | 466, 642 |

### LABOR AND WAGES.

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of foremen or overseers | 7 | |
| Total wages paid all workmen of this class in 1889 | .... | $4,685 |
| Number of mechanics | 93 | |
| Total wages paid all workmen of this class in 1889 | .... | 12,837 |
| Number of laborers | 88 | |
| Total wages paid all workmen of this class in 1889 | .... | 42,739 |
| Office force: | | |
| Total number (males) | 1 | |
| Total wages paid (males) | .... | 624 |
| Total number of persons employed and wages paid in 1889 | 189 | 60,885 |

| | |
|---|---|
| Wages paid for labor: | |
| In building rigs | $2,703 |
| In drilling wells | 15,482 |
| In operating and caring for wells | 41,570 |
| In torpedoing wells | 431 |
| In building or repairing tankage | 75 |
| In office | 624 |
| Total | 60,885 |

### CLASSIFIED WAGES.

| CLASS OF LABOR. | Number of each class. | Range of wages. |
|---|---|---|
| Foremen | 5 | $60 to $75 per month. |
| Pumpers or engineers | 69 | $8 to $57.50 per month. |
| Carpenters | 15 | $1.75 to $3 per day. |
| Rig builders | 20 | $35 to $80 per rig. |
| Drillers | 59 | 50 to 60 cents per foot. |
| Tool dressers | 2 | $2.50 per day. |
| Laborers | 12 | $1.50 to $2 per day. |
| Teamsters | 1 | $1.50 per day. |
| Sundry mechanics | 1 | $5.27 per day. |

## OHIO.

The oil-producing sections of Ohio may be roughly divided into 3 districts, as follows: (1) The Lima, or Northwestern, including the remarkable developments in the district of which Lima may be regarded as the center, and including the production in Allen, Auglaize, Hancock, Sandusky, and Wood counties. The oil from this district is found in the Trenton limestone. (2) The Macksburg district, which may be regarded as including the wells in Washington, Noble, Belmont, and Harrison counties. Though there are several productive sands in this district, the chief producer is the Berea grit. (3) This district includes the old well-known Mecca and Belden fields. These also derive their oil from the Berea. These districts will be more fully described in speaking of the statistics of production of each.

### PRODUCTION.

The total production and value and the value per barrel of the petroleum produced in the several districts of Ohio in 1889 were as follows:

TOTAL PRODUCTION AND VALUE AND VALUE PER BARREL OF PETROLEUM PRODUCED IN OHIO IN 1889.

| DISTRICTS. | Total production. (Barrels.) | Total value. | Value per barrel. |
|---|---|---|---|
| Total | 12,471,466 | $2,173,995 | $0.17⅜ |
| Lima | 12,153,189 | 1,822,978 | 0.15 |
| Macksburg | 317,037 | 340,683 | 1.07½ |
| Mecca-Belden | 1,240 | 10,334 | 8.33⅜ |

In the classification of this oil all of that produced in Lima is classed as fuel oil, that of Macksburg district as illuminating, and all of that produced in the Mecca-Belden district as lubricating oil. This classification is correct with the exception of the Lima district. While it is true that most of the Lima oil that was consumed in 1889 was used as fuel, strenuous efforts were being made to find a method for refining it, so that considerable of the oil that was produced in 1889 and went into pipe-line stocks has since been used for illuminating purposes, the oil producing some 22 per cent of illuminants, the balance being sold for fuel purposes. All of the oil produced in the Mecca-Belden district was used for lubricating purposes, and all of that produced in the Macksburg district was what may be termed refinery oil, or for manufacture into illuminating oil.

From the above statement it will be seen that the total production of petroleum in Ohio in 1889 was 12,471,466 barrels, of which the Lima field produced 12,153,189 barrels, or 97.45 per cent, the Macksburg district 317,037 barrels, or 2.54 per cent, and the Mecca-Belden district 1,240 barrels, or a little less than 0.01 of 1 per cent. The total value of this oil was $2,173,995, or an average of 17⅜ cents per barrel. The oil from the Lima district was valued at $1,822,978, or 15 cents a barrel; that from the Macksburg district at $340,683, or $1.07½ per barrel, and that from the Mecca-Belden district at $10,334, or $8.33⅜ per barrel. But little need be said as to these values. The Lima oil was produced in such quantities, it was so difficult to refine because of its odor (resulting from the sulphur compounds contained in it), and its distance from large manufacturing centers was so great that its price was exceedingly low, 15 cents per barrel. In 1889 two prices ruled for Macksburg oil. That known as shallow oil, representing the oil produced from the shallow wells, which was of a better quality than that from deep wells, commanded a premium of 10 cents a barrel above pipe-line certificates. In September, 1889, this premium was extended to a little oil produced at Glencoe, Belmont county, and about the middle of November to the Eureka shallow oil, produced on the Ohio side of the river. Macksburg deep oil commanded no premium in 1889. Two-thirds of the oil produced in the Macksburg district was shallow oil. The product of lubricating oil in the Mecca-Belden district was sold exclusively for lubricating purposes, at about 20 cents a gallon.

The total production of petroleum in Ohio since the beginning of operations in that state is placed at 30,512,542 barrels. The production by years since 1876 is as follows:

PRODUCTION OF PETROLEUM IN OHIO FROM 1876 TO 1889, BY YEARS.

| | BARRELS. |
|---|---|
| 1876 | 31,763 |
| 1877 | 29,888 |
| 1878 | 38,179 |
| 1879 | 29,112 |
| 1880 | 38,940 |
| 1881 | 33,867 |
| 1882 | 39,761 |
| 1883 | 47,632 |
| 1884 | 90,081 |
| 1885 | 650,000 |
| 1886 | 1,782,970 |
| 1887 | 5,018,015 |
| 1888 | 10,010,868 |
| 1889 | 12,471,466 |
| Total | 30,312,542 |

To this total of 30,312,542 are added, in the table of production of crude petroleum in the United States from 1859 to 1889, 200,000 barrels, which is estimated to include all the production in Ohio prior to 1876, making the total production, as given, 30,512,542 barrels. In the above table will be noted the enormous increase in production, beginning with 1885, which marks the commencement of developments in the Lima field. The production of this field, as shown elsewhere, was 1,064,025 barrels in 1886, 4,650,375 in 1887, 9,682,683 in 1888, and 12,153,189 in 1889.

## STOCKS.

The total stocks of oil held in Ohio December 31, 1888, were 10,243,066 barrels, of which 10,161,842 barrels were held by the pipe lines and 81,224 were held in stock at the wells. At the close of 1889 these stocks had increased to 14,886,122 barrels, of which 14,415,997 barrels were held by the pipe lines and 470,125 at the wells. The distribution of these stocks by districts is shown in the following table:

STOCKS OF PETROLEUM IN OHIO DECEMBER 31, 1888, AND DECEMBER 31, 1889.

[Barrels.]

| PERIODS. | Total. | Lima. | Macksburg. | Mecca-Belden. |
|---|---|---|---|---|
| December 31, 1888: | | | | |
| Pipe-line stocks | 10,161,842 | 9,810,714 | 351,128 | ........ |
| At wells | 81,224 | 78,118 | 2,726 | 380 |
| Total at close of 1888 | 10,243,066 | 9,888,832 | 353,854 | 380 |
| December 31, 1889: | | | | |
| Pipe-line stocks | 14,415,997 | 14,105,149 | 310,848 | ........ |
| At wells | 470,125 | 466,308 | 3,337 | 480 |
| Total at close of 1889 | 14,886,122 | 14,571,457 | 314,185 | 480 |

From the preceding table it will appear that not only was all the oil produced in the Macksburg district in 1889 disposed of, but stocks were drawn on to the extent of nearly 40,000 barrels. The stocks in this district at the close of 1889 were actually 39,669 barrels less than at the close of 1888. On the other hand, stocks in the Lima district had increased 4,682,625 barrels, which would indicate a consumption of 7,470,564 barrels of Lima oil in 1889. It should be remembered, however, that reductions in stocks in the pipe lines do not always indicate actual consumption, as oil may be carried in tanks outside of those owned by the pipe lines.

## WELLS.

The total number of wells in all districts in Ohio at the close of 1889 was 2,640, of which 2,242 were in the Lima district, 390 in the Macksburg district, and 8 in the Mecca-Belden district. At the close of 1888 there were 1,788 wells in the state, the increase in 1889 being 852. Of this increase, 777 were in the Lima field, 73 in the Macksburg, and 2 in the Mecca-Belden.

During the year 759 producing wells are reported as having been completed. Of these, 667 were completed in the Lima district, 86 in the Macksburg district, and 6 in the Mecca-Belden district. The initial daily production of all of these wells was 55,930 barrels, an average of $73\frac{7}{10}$ barrels. The average initial production per well in the Lima district was $82\frac{1}{5}$ barrels per day, the Macksburg district $13\frac{1}{10}$, the Mecca-Belden $\frac{1}{2}$ barrel.

The well statistics for the whole state of Ohio for 1889 are as follows:

### WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 1,788 |
| Total number of producing wells December 31, 1889 | 2,640 |
| Total number of flowing wells December 31, 1888 | 255 |
| Total number of flowing wells December 31, 1889 | 785 |
| Total number of pumping wells December 31, 1888 | 1,533 |
| Total number of pumping wells December 31, 1889 | 1,855 |
| Number of wells completed in 1889 | 825 |
| Number of dry holes in 1889 | 66 |
| Number of producing wells completed in 1889 | 759 |
| Initial daily production of new wells (barrels) | 55,930 |
| Number of rigs building December 31, 1888 | 26 |
| Number of rigs building December 31, 1889 | 59 |
| Number of wells drilling December 31, 1888 | 38 |
| Number of wells drilling December 31, 1889 | 45 |
| Value of materials used in pumping, caring for, and operating wells in 1889 | $650,503 |

## CAPITAL.

The total capital invested in the oil business in Ohio in 1889, according to the reports received, was $17,771,152. Of this, $9,963,302 represents the value of land and $7,807,850 the value of wells, tanks, pipe lines, oil in stock at wells, and other property and improvements.

Of the total capital as above stated $16,802,637 was invested in the Lima district, $944,721 in the Macksburg district, and $23,794 in the Mecca-Belden district.

Of the $7,807,850 invested in wells, etc., $6,627,835 was invested in wells proper, including the rigs, engines, boilers, etc., $373,052 in tanks, and $123,762 in pipe lines at wells, not including those belonging to pipe-line companies; $76,063 represents the stock of oil at the wells on December 31, 1889, while $607,138 represents the value of other property, including cash and improvements.

The total acreage of oil lands, both owned and leased, is 440,401. Of this, 23,513 acres are reported as owned and 416,888 acres as leased. The total value of this land, both owned and leased, is given as $9,963,302. This is but $23 an acre, ignoring fractions, for all the oil lands throughout the state. The value of the 371,619 acres of oil lands in the Lima district is given as $9,693,466, an average of $26 an acre; that of the 68,171 acres of land in the Macksburg district is stated to be $255,841, an average of only $4 an acre; while the value of the 611 acres in the Mecca-Belden district is $13,995, or an average of $23 an acre. It is evident, as has already been stated in connection with the general discussion of the value of oil lands, that this is an underestimate, the probability being that to the actual value of the land owned is added the actual amount of money paid for the leased land, and these two sums are taken as the total value of all the land. Even with Lima oil at the prices ruling in 1889, $100 an acre would be a very low estimate of the average value of the oil lands in the state of Ohio, and this amount would place these lands at $44,040,100, instead of a little less than $10,000,000.

The total value of the wells, including rigs, engines, boilers, casings, etc., but excluding the tanks and pipe lines, as given below, is $6,627,835. Of this amount, $5,990,285 represents the value of the wells in the Lima district, $630,950 the value of those in the Macksburg district, and $6,600 the value of those in the Mecca-Belden district. This would make the value of each well in the Lima district $2,672, in the Macksburg district $1,618, and in the Mecca-Belden district $825. As has already been stated, it is the usual custom in oil districts to estimate the value of a well at about what the casing, etc., would be worth to remove to another well, and not by its producing capacity.

The consolidated statistics of the capital in all of the districts of Ohio are as follows:

STATISTICS OF THE CAPITAL EMPLOYED IN THE OHIO FIELDS IN 1889.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $17,771,152 |
| Number of acres of oil land: | | |
| Owned | 23,513 | |
| Leased | 416,888 | |
| Total acreage | 440,401 | |
| Present value of land, both owned and leased | | 9,963,302 |
| Average value per acre, $23. | | |
| Value of rigs, wells, engines, boilers, etc. | | $6,627,835 |
| Value of tanks | | 373,052 |
| Value of pipe lines at wells owned by parties making report | | 123,762 |
| Value of oil in stock at wells December 31, 1889 | | 76,063 |
| Value of other property and improvements | | 607,138 |
| Total | | 7,807,850 |

### LABOR AND WAGES.

The same remarks as to the value of the statistics of labor and wages given in the general discussion of this subject in a previous part of this report will apply to the figures concerning Ohio. In a general way it may be said that a large proportion of the work of building rigs, drilling and torpedoing wells, and erecting tankage is done by contract, and the items for the labor in connection with these operations do not appear in this report; so also the general classification of foremen or overseers, mechanics, laborers, and boys is confusing and misleading, different proprietors classifying the same workmen under different heads, as, for instance, a pumper who has charge of the works at the well will be in some cases classed as a foreman, in others as a mechanic, and in others as a laborer.

The total number of employés at the oil wells in Ohio at the close of 1889 was 2,123. There was paid for labor by the proprietors of the wells, not including, as stated above, that paid drillers working by contract, $836,377. Of the employés, 1,798 were in the Lima district, 318 in the Macksburg, and 7 in the Mecca-Belden district. The amount of wages paid in the Lima district was $722,975, in the Macksburg $111,402, and in the Mecca-Belden district $2,000.

There were 94 men classed as overseers, to whom $71,613 was paid in wages; 724 classed as mechanics, to whom $235,607 was paid, and 1,282 classed as laborers, to whom $509,421 was paid. No boys under 16 years are reported as having been employed at wells, and the total office force reported was 23, to whom $19,736 was paid in wages. This last item evidently includes only employés in offices, even if it includes all who are regarded as office force, and does not include owners, proprietors, or officers of companies.

The wages paid for labor in building rigs in Ohio, with the exceptions above noted, was $30,254; for drilling wells, $174,299; in operating and caring for wells, $595,518; in torpedoing wells, $3,728; in building or repairing tankage, $9,440; in building and repairing pipe lines, $3,402, and in the office, $19,736.

The statistics of labor and wages in the Ohio oil fields in 1889 are as follows:

LABOR AND WAGES.

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of foremen or overseers | 94 | |
| Total wages paid all workmen of this class in 1889 | ..... | $71,613 |
| Number of mechanics | 724 | |
| Total wages paid all workmen of this class in 1889 | ..... | 235,607 |
| Number of laborers | 1,282 | |
| Total wages paid all workmen of this class in 1889 | ..... | 509,421 |
| Office force: | | |
| Total number (males) | 23 | |
| Total wages paid (males) | ..... | 19,736 |
| Total number of persons employed and wages paid in 1889 | 2,123 | 836,377 |

| | |
|---|---|
| Wages paid for labor: | |
| In building rigs | $30,254 |
| In drilling wells | 174,299 |
| In operating and caring for wells | 595,518 |
| In torpedoing wells | 3,728 |
| In building or repairing tankage | 9,440 |
| In building and repairing pipe lines | 3,402 |
| In office | 19,736 |
| Total | 836,377 |

### LIMA DISTRICT.

Probably the most remarkable oil district ever developed in this country is that known as the Lima or Northwestern Ohio district. Its discovery opened up a new horizon (the Trenton limestone) as an oil producer. Its development has been rapid since it first began to assume prominence in 1885, and its production has increased enormously. For a while it was believed that the character of the oil was such that no market could be found for it for illuminating purposes, but this theory has been exploded, and it is safe to predict that in the near future a large portion of the demand for illuminating oil, at least in the United States, will be supplied by the distillate from the limestone oil.

The Lima oil field, according to Professor Orton, who has written most fully upon it, constitutes a flat-lying tract of the Trenton limestone. It is as near a level terrace as an area of this sort ever becomes. The very gentle slope that exists in it is mainly to the northward, not amounting to more than 4 feet to the mile, and at times reduced even to 1 or 2 feet. The rises in the floor, or, in other words, the knobs and bosses of this great limestone sheet, are always favorable to production, other things being equal. In this field are included all of the oil-producing districts in northwestern Ohio. They are generally divided into the Lima, Findlay, New Baltimore, Saint Marys, Gibsonburg, Upper Sandusky, and Spencerville fields. Oil was produced in this district in 1889 in Auglaize, Hancock, Mercer, Sandusky, and Wood counties.

The oil is found at Lima at a depth of about 1,300 feet. It requires about 60 days to drill a well, the cost being some $2,500. The first wells drilled in this territory were none of them very large producers. Early in 1886 no well exceeded, if, indeed, any reached, 150 barrels a day. Toward the close of 1886 and the first of 1887, however, some very large wells were brought in, one being reported at 1,500 barrels a day, another reaching the 1,000-barrel limit, and others maintaining a rate of several hundred barrels per day, week after week. In 1889 the average production of the new wells in this district was 80½ barrels, some wells yielding as high as 1,500 barrels and others dropping as low as 30 barrels, from 50 to 75 barrels being the most common figures of production.

The Lima oil and, indeed, all limestone oils differ greatly in character from the oils of the sandstones. They are dark or black and rather heavy, and contain sulphur compounds. In these respects the oils of northwestern Ohio resemble those of Canada and Tennessee. These oils, though they would be classed as rather heavy, differ greatly in specific gravity. In the first wells struck the oil had a gravity of 36° B.; in the later wells it reaches 37° or 38°, and in some even 41°.

There have been two great drawbacks to the use of Lima oil for illuminating purposes: first, the presence of sulphur compounds, and, secondly, the yield as compared with the Pennsylvania oils. It is claimed that a way has been found to deprive this oil of its sulphur, and the price and market that are being obtained for the residuum after distilling off the illuminating oil have largely done away with the second objection. As is stated elsewhere, this oil has largely entered into use as an illuminator.

The production of petroleum in the Lima (Ohio) oil fields from 1886 to 1889 is as follows:

PRODUCTION OF PETROLEUM IN THE LIMA (OHIO) DISTRICT FROM 1886 TO 1889.

| | BARRELS. |
|---|---|
| 1886 | 1, 064, 025 |
| 1887 | 4, 650, 375 |
| 1888 | 9, 682, 683 |
| 1889 | 12, 153, 189 |

The statistics of the production of petroleum in the Lima field in 1889 are as follows:

TOTAL PRODUCTION AND VALUE.

| | |
|---|---|
| Total production in 1889 (barrels of 42 gallons) | 12, 153, 189 |
| Total value at wells of all oil produced, excluding pipage | $1, 822, 978 |
| Value per barrel | $0. 15 |

STOCKS OF FUEL OIL ON HAND AT WELLS. •

| | BARRELS. |
|---|---|
| December 31, 1888 | 78, 118 |
| December 31, 1889 | 466, 308 |

## WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 1,465 |
| Total number of producing wells December 31, 1889 | 2,242 |
| Total number of flowing wells December 31, 1888 | 157 |
| Total number of flowing wells December 31, 1889 | 682 |
| Total number of pumping wells December 31, 1888 | 1,308 |
| Total number of pumping wells December 31, 1889 | 1,560 |
| Number of wells completed in 1889 | 701 |
| Number of dry holes in 1889 | 34 |
| Number of producing wells completed in 1889 | 667 |
| Initial daily production of new wells (barrels) | 54,800 |
| Number of rigs building December 31, 1888 | 23 |
| Number of rigs building December 31, 1889 | 57 |
| Number of wells drilling December 31, 1888 | 33 |
| Number of wells drilling December 31, 1889 | 38 |
| Value of materials used in pumping, caring for, and operating wells in 1889 | $318,000 |

## CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $16,802,637 |
| Number of acres of oil land: | | |
| Owned | 22,477 | |
| Leased | 349,142 | |
| Total acreage | 371,619 | |
| Present value of land, both owned and leased | | 9,693,466 |
| Average value per acre, $26. | | |
| Value of rigs, wells, engines, boilers, etc | | $5,990,285 |
| Value of tanks | | 355,157 |
| Value of pipe lines at wells owned by parties making report | | 117,049 |
| Value of oil in stock at wells December 31, 1889 | | 69,946 |
| Value of other property and improvements | | 576,734 |
| Total | | 7,109,171 |

## LABOR AND WAGES.

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of foremen or overseers | 86 | |
| Total wages paid all workmen of this class in 1889 | | $65,563 |
| Number of mechanics | 557 | |
| Total wages paid all workmen of this class in 1889 | | 183,210 |
| Number of laborers | 1,134 | |
| Total wages paid all workmen of this class in 1889 | | 454,826 |
| Office force: | | |
| Total number (males) | 21 | |
| Total wages paid (males) | | 19,376 |
| Total number of persons employed and wages paid in 1889 | 1,798 | 722,975 |

| | |
|---|---|
| Wages paid for labor: | |
| In building rigs | $22,352 |
| In drilling wells | 129,638 |
| In operating and caring for wells | 537,201 |
| In torpedoing wells | 3,728 |
| In building or repairing tankage | 7,640 |
| In building and repairing pipe lines | 3,040 |
| In office | 19,376 |
| Total | 722,975 |

## CLASSIFIED WAGES.

| CLASS OF LABOR. | Number of each class. | Range of wages. |
|---|---|---|
| Foremen | 81 | $15 to $214 per month. |
| Pumpers or engineers | 977 | $5 to $75 per month. |
| Carpenters | 48 | $2.50 per day. |
| Rig builders | 151 | $60 to $125 per rig. |
| Drillers | 276 | 45 to 80 cents per foot. |
| Tool dressers | 5 | $3 per day. |
| Laborers | 186 | $1 to $2 per day. |
| Teamsters | 5 | $3 to $5 per day. |
| Well cleaners | 20 | $3.50 to $5 per day. |
| Sundry mechanics | 13 | $2.25 to $2.50 per day. |

### MACKSBURG (OHIO) DISTRICT.

The second largest oil-producing district in Ohio, and the one producing oil that compares with the best product of Pennsylvania, is that known as the Macksburg district. The chief production of this district is in Washington county, but a large quantity is reported also from Noble county, and small amounts from Harrison and Belmont counties.

The development of the Macksburg district was almost coincident with that of the western Pennsylvania oil fields, the first well having been bored in 1860. This well was but 56 feet deep, and yielded many thousands of barrels of heavy lubricating oil. It is reported that at first the daily yield was from 100 to 200 barrels. A well a short distance west of this yielded at first 150 barrels a day. Notwithstanding the early exploitation of this district, it however assumed but little importance until the spring of 1884, when a number of successful wells were bored. During 1885 the production increased rapidly, the runs through the Macksburg pipe line being 661,586 barrels. In 1886 the production reached 703,945 barrels, and this was the year of its greatest output.

The production of the Macksburg district for the last 5 years has been as follows:

PRODUCTION OF PETROLEUM IN THE MACKSBURG (OHIO) DISTRICT FROM 1885 TO 1889.

| | BARRELS. |
|---|---|
| 1885 | 661,586 |
| 1886 | 703,945 |
| 1887 | 372,257 |
| 1888 | 291,585 |
| 1889 | 317,037 |

Though oil is produced from 4 sands in this field, the important one is the Berea grit. The first oil well in this formation was struck in 1878, and was a 10-barrel flowing well.

Search for oil in this horizon in 1889 was quite persistent. A dozen wells were drilled near Cadiz, several of which started with a production of from 5 to 10 barrels of oil per day, only a few maintaining a production of 4 or 5 barrels at the close of the year. In Belmont and Jefferson counties some work was done, but the result was, on the whole, somewhat unsatisfactory.

The statistics of the production of petroleum in the Macksburg district in 1889 are as follows:

TOTAL PRODUCTION AND VALUE.

| | |
|---|---|
| Total production in 1889 (barrels of 42 gallons) | 317,037 |
| Total value at wells of all oil produced, excluding pipage | $340,683 |
| Value per barrel | $1.07½ |

STOCKS OF OIL ON HAND AT WELLS.

| | BARRELS. |
|---|---|
| December 31, 1888 | 2,726 |
| December 31, 1889 | 3,337 |

WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 317 |
| Total number of producing wells December 31, 1889 | 390 |
| Total number of flowing wells December 31, 1888 | 98 |
| Total number of flowing wells December 31, 1889 | 103 |
| Total number of pumping wells December 31, 1888 | 219 |
| Total number of pumping wells December 31, 1889 | 287 |
| Number of wells completed in 1889 | 118 |
| Number of dry holes in 1889 | 32 |
| Number of producing wells completed in 1889 | 86 |
| Initial daily production of new wells (barrels) | 1,127 |
| Number of rigs building December 31, 1888 | 3 |
| Number of rigs building December 31, 1889 | 2 |
| Number of wells drilling December 31, 1888 | 5 |
| Number of wells drilling December 31, 1889 | 7 |
| Value of materials used in caring for and operating wells in 1889 | $331,255 |

### CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $944,721 |
| Number of acres of oil land: | | |
| Owned | 745 | |
| Leased | 67,426 | |
| Total acreage | 68,171 | |
| Present value of land, both owned and leased | | 255,841 |
| Average value per acre, $4. | | |
| Value of rigs, wells, engines, boilers, etc | | 630,950 |
| Value of tanks | | 17,450 |
| Value of pipe lines at wells owned by parties making report | | 6,695 |
| Value of oil in stock at wells December 31, 1889 | | 3,731 |
| Value of other property and improvements | | 30,054 |
| Total | | 688,880 |

### LABOR AND WAGES.

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of foremen or overseers | 8 | |
| Total wages paid all workmen of this class in 1889 | ..... | $6,050 |
| Number of mechanics | 167 | |
| Total wages paid all workmen of this class in 1889 | ..... | 52,397 |
| Number of laborers | 141 | |
| Total wages paid all workmen of this class in 1889 | ..... | 52,595 |
| Office force: | | |
| Total number (males) | 2 | |
| Total wages paid (males) | ..... | 360 |
| Total number of persons employed and wages paid in 1889 | 318 | 111,402 |

| | |
|---|---|
| Wages paid for labor: | |
| In building rigs | $7,902 |
| In drilling wells | 44,661 |
| In operating and caring for wells | 56,317 |
| In building or repairing tankage | 1,800 |
| In building and repairing pipe lines | 362 |
| In office | 360 |
| Total | 111,402 |

### CLASSIFIED WAGES.

| CLASS OF LABOR. | Number of each class. | Range of wages. |
|---|---|---|
| Foremen | 10 | $40 to $75 per month. |
| Pumpers or engineers | 111 | $10 to $60 per month. |
| Carpenters | 41 | $2.50 per day. |
| Rig builders | 75 | $50 to $205 per rig. |
| Drillers | 131 | 45 to 60 cents per foot. |
| Tool dressers | 13 | $2 to $3.50 per day. |
| Laborers | 24 | $1 to $2 per day. |
| Teamsters | 3 | $3 to $5 per day. |
| Sundry mechanics | 3 | $2.50 per day. |

### MECCA-BELDEN DISTRICT.

The wells in this district are located in Lorain and Trumbull counties, and include the Grafton and Mecca-Belden districts. All the oils in this district are from the Berea grit.

The Mecca district produces a lubricating oil from a few shallow wells. The total production in 1889 was 1,240 barrels, worth at the railroad station, 3 miles distant, package included, from 30 to 35 cents, according to quality. There were 8 producing wells in 1889, and all were pumped by heads. The oil is obtained mixed with water highly charged with sulphurated hydrogen, as many as 1,000 barrels of water being often pumped out for 1 barrel of oil. The wells are owned and operated by farmers, who engage in this work when circumstances permit. The wells range from 50 to 60 feet deep, at which depth a fissure or crevice is found containing inexhaustible quantities of water, carrying a greater or less amount of oil. This water is collected and the oil permitted to settle, when it is skimmed off and, after settling, is heated by steam to still further drive off the water, and it is then put up in barrels and sold. A well was drilled in 1889 to a depth of 2,375 feet with the hope of obtaining a larger amount of oil, but without success.

There are no productive wells now in Mecca proper, all being in East Mecca.

The oil obtained from Grafton, in Lorain county, is lighter than that obtained at Mecca. The wells in what is commonly known as the Grafton district, but which is more properly called the Belden district (no producing wells now being located at Grafton), range in depth from 150 to 250 feet. The wells are steady though small producers, one having yielded about 50 gallons of oil per day for 10 years. This well is pumped by heads, and is the only well in the district that is cased off. While the oil produced here is charged with sulphur, it is not as strong as that at Mecca. The well referred to produces a small amount of natural gas, which is used under the boiler at the well. The production in this district, while small, is of a high grade, and will probably be continued for years.

The statistics of the production of petroleum in the Mecca-Belden district of Ohio in 1889 are as follows:

### TOTAL PRODUCTION AND VALUE.

| | |
|---|---|
| Total production in 1889 (barrels of 42 gallons) | 1, 240 |
| Total value at wells of all oil produced, excluding pipage | $10, 334 |
| Value per barrel | $8. 33⅜ |

### STOCKS OF LUBRICATING OIL ON HAND AT THE WELLS.

| | BARRELS. |
|---|---|
| December 31, 1888 | 380 |
| December 31, 1889 | 480 |

### WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 6 |
| Total number of producing wells December 31, 1889 | 8 |
| Total number of pumping wells December 31, 1888 | 6 |
| Total number of pumping wells December 31, 1889 | 8 |
| Number of wells completed in 1889 | 6 |
| Number of producing wells completed in 1889 | 6 |
| Initial daily production of new wells (barrels) | 3 |
| Value of materials used in caring for and operating wells in 1889 | $1, 248 |

### CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $23, 794 |
| Number of acres of oil land: | | |
| Owned | 291 | |
| Leased | 320 | |
| Total acreage | 611 | |
| Present value of land, both owned and leased | | 13, 995 |
| Average value per acre, $23. | | |
| Value of rigs, wells, engines, boilers, etc | | $6, 600 |
| Value of tanks | | 445 |
| Value of pipe lines at wells owned by parties making report | | 18 |
| Value of oil in stock at wells December 31, 1889 | | 2, 386 |
| Value of other property and improvements | | 350 |
| Total | | 9, 799 |

### LABOR AND WAGES.

| | |
|---|---|
| Total number of persons employed in 1889 | 7 |
| Total wages paid all workmen | a$2, 000 |

a Paid for operating and caring for wells.

The rates of wages paid pumpers or engineers ranged from $15 to $42.50 per month.

## WEST VIRGINIA.

The oil fields of West Virginia divide themselves geographically into 4 districts, namely, the Turkey Foot district, in Hancock county, which is a continuation of the Pennsylvania oil fields; the Mount Morris district, which includes the wells in Monongalia county and the developments in progress in Marion county; the Volcano and Eureka districts, the Volcano being in Wood and Ritchie counties and the Eureka in Pleasants county, a continuation of a field of the same name in Ohio, and the old Burning Springs district, in Wirt county.

In the Turkey Foot, Mount Morris, and Burning Springs districts the entire production is classed as illuminating oil, while of the production of the Volcano and Eureka districts 142,133 barrels are illuminating and 23,602 barrels lubricating.

Petroleum has been known to exist in West Virginia from the earliest times. As far back as 1771 Jefferson gave an interesting description of a burning spring and the oil connected with it in the Great Kanawha valley. Up to 1865, however, but little oil had been produced except in prospecting, but in this and the succeeding years operations began almost simultaneously at a number of points, including Burning Springs and Volcano. Considerable quantities of oil were found at these places, it being light at most points, except at Volcano. The light-oil regions ran a rapid course, giving a large yield during their productive career, and ceased to be of importance until recently. The developments in Pennsylvania and the Macksburg (Ohio) region have extended into West Virginia, and the Turkey Foot and Mount Morris regions represent a continuation of the Pennsylvania oil fields and the Eureka of the Macksburg field, while the Volcano and Burning Springs remain producers.

Up to 1876 it was estimated that the production of oil in West Virginia had been 3,000,000 barrels, varying in specific gravity from 27° to 45° B., the greater portion varying from 27° to 33°.

The descriptions given in Pennsylvania of the Lower oil field, the character of the strata and of the oil produced, will apply to the Mount Morris and the Turkey Foot districts. That given in Ohio concerning the Macksburg district will apply to the Eureka. Regarding the other districts, it is sufficient to say that in most of the producing wells of the Volcano and Burning Springs districts the oil is found near the top of the carboniferous rocks.

The production of the Volcano region consists of five grades of oil, ranging in gravity from 28° to 44°, the light oils ranging from 35° to 44° and the heavy oils from 28° to 31.5°. It is estimated that about one-fifth of the heavy oil is of 28° gravity and less than 29°, one-fourth from 29° to 30°, seven-twentieths from 30° to 31°, and one-fifth 31°. This heavy oil seems to be a special production of the Wood county field.

## PRODUCTION.

The total production of petroleum in West Virginia in 1889 was 544,113 barrels, valued at $653,827, or $1.20⅛ per barrel. Of this amount the Turkey Foot district produced 199,460 barrels; the Mount Morris, 174,758 barrels; the Volcano and Eureka, 165,735 barrels, of which 23,602 barrels were lubricating, and the Burning Springs, 4,160 barrels; making a total of 520,511 barrels of illuminating oil, valued at $595,730, or $1.14½ per barrel, and 23,602 barrels of lubricating oil, valued at $58,097, or $2.46⅛ per barrel. Tabulating these figures, the result is as follows:

TOTAL PRODUCTION AND VALUE OF PETROLEUM PRODUCED IN WEST VIRGINIA IN 1889.

| DISTRICTS. | TOTAL. | | | ILLUMINATING. | | | LUBRICATING. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total production. (Barrels.) | Total value. | Price per barrel. | Total production. (Barrels.) | Total value. | Price per barrel. | Total production. (Barrels.) | Total value. | Price per barrel. |
| Total | 544, 113 | $653, 827 | $1. 20⅛ | 520, 511 | $595, 730 | $1. 14½ | 23, 602 | $58, 097 | $2. 46⅛ |
| Turkey Foot | 199, 460 | 243, 192 | 1. 21⅞ | 199, 460 | 243, 192 | 1. 21⅞ | | | |
| Mount Morris | 174, 758 | 194, 949 | 1. 11½ | 174, 758 | 194, 949 | 1. 11½ | | | |
| Volcano and Eureka | 165, 735 | 211, 526 | 1. 27⅝ | 142, 133 | 153, 429 | 1. 07⅞ | 23, 602 | 58, 097 | 2. 46⅛ |
| Burning Springs | 4, 160 | 4, 160 | 1. 00 | 4, 160 | 4, 160 | 1. 00 | | | |

## PRODUCTION AND STOCKS.

There are no separate reports of stocks of West Virginia oil held by pipe lines. The stocks held in Turkey Foot and Mount Morris are probably reported with the stocks of the pipe line in southwestern Pennsylvania, while the stocks of Eureka oil held by pipe lines are in the Macksburg report. There were, however, 6,104 barrels of oil in stock at wells December 31, 1888, and 6,835 barrels December 31, 1889. As the production of December, 1888, was 19,060 barrels, this would make the stocks at wells at the close of December, 1888, 32.03 per cent of the production of that month. The production of December, 1889, was 81,453 barrels, and 6,835 barrels were held in stock at wells at the close of the month, making stocks at wells but 8.39 per cent of the production for that month.

The number of producing wells in West Virginia at the close of December, 1888, was 505, and 623 at the close of December, 1889. Of the wells producing in this field at the close of 1888, 8 were flowing and 497 pumping. At the close of 1889 there were 23 wells flowing and 600 pumping. The well statistics for the entire region are as follows:

WELL RECORD.

| ITEMS. | Total. | Turkey Foot. | Mount Morris. | Volcano and Eureka. | Burning Springs. |
|---|---|---|---|---|---|
| Total number of producing wells December 31, 1888 | 505 | 5 | | 493 | 7 |
| Total number of producing wells December 31. 1889 | 623 | 103 | 23 | 490 | 7 |
| Total number of flowing wells December 31, 1888 | 8 | | | 7 | 1 |
| Total number of flowing wells December 31, 1889 | 23 | 11 | 3 | 8 | 1 |
| Total number of pumping wells December 31, 1888 | 497 | 5 | | 486 | 6 |
| Total number of pumping wells December 31, 1889 | 600 | 92 | 20 | 482 | 6 |
| Number of wells completed in 1889 | 206 | 153 | 24 | 29 | |
| Number of dry holes in 1889 | 41 | 40 | 1 | | |
| Number of producing wells completed in 1889 | 165 | 113 | 23 | 29 | |
| Initial daily production of new wells (barrels) | 7,591 | 3,726 | 3,298 | 567 | |
| Number of rigs building December 31, 1888 | 5 | 2 | 1 | 2 | |
| Number of rigs building December 31, 1889 | 16 | 11 | 3 | 2 | |
| Number of wells drilling December 31, 1888 | 5 | 2 | | 3 | |
| Number of wells drilling December 31, 1889 | 24 | 15 | 4 | 5 | |
| Value of materials used in caring for and operating wells in 1889 | $122,769 | $92,254 | $25,136 | $5,379 | |

The total capital invested in oil production in West Virginia in 1889 was $1,472,598. Of this amount $411,663 represents the value of land and $1,060,935 the value of other property.

The amount of land held as oil land in this state is 120,219 acres, of which 396 acres were owned and 119,823 acres leased. The value of this land was $411,663, or, ignoring fractions, $3 an acre. To this amount should be added 17,630 acres of land leased for oil purposes on which no developments have been made, representing an outlay for leases of $10,243.

The total amount of capital invested in other property was $1,060,935. Of this amount $985,769 represents the value of rigs, wells, etc., $35,904 the value of tanks, $3,775 the value of pipe lines, $17,713 the value of oil in stock at wells, and $17,774 the value of other property.

As there were 623 producing wells in this state at the close of the year, and the value of these wells was $985,769, the value of each well would be $1,582.

The remarks made in Pennsylvania in discussing the question of land and value of wells will apply here also.

In the following table will be found a statement of the capital used in West Virginia, by districts, and its division into totals of land and other property:

CAPITAL INVESTED, BY DISTRICTS.

| DISTRICTS. | Total capital. | Value of land. | Total value of other property. |
|---|---|---|---|
| Total | $1,472,598 | $411,663 | $1,060,935 |
| Turkey Foot | 489,180 | 188,173 | 301,007 |
| Mount Morris | 501,254 | 142,111 | 359,143 |
| Volcano and Eureka | 476,028 | 80,718 | 395,310 |
| Burning Springs | 6,136 | 661 | 5,475 |

The following table shows the acreage of land in each district in West Virginia, together with the value of the same and the value per acre:

ACREAGE AND VALUE OF LAND.

| DISTRICTS. | NUMBER OF ACRES. | | | Total value. | Value per acre. |
|---|---|---|---|---|---|
| | Total. | Owned. | Leased. | | |
| Total | 120,219 | 396 | 119,823 | $411,663 | $3.42 |
| Turkey Foot | 32,345 | 50 | 32,295 | 188,173 | 5.82 |
| Mount Morris | 49,307 | 244 | 49,063 | 142,111 | 2.88 |
| Volcano and Eureka | 36,595 | 100 | 36,495 | 80,718 | 2.21 |
| Burning Springs | 1,972 | 2 | 1,970 | 661 | 0.34 |

In the following table will be found the division of the capital invested in West Virginia other than in land:

DIVISION OF CAPITAL OTHER THAN LAND.

| DISTRICTS. | Total. | Rigs, wells, etc. | Tanks. | Pipe line. | Oil in stock. | Other property. | Value per well. |
|---|---|---|---|---|---|---|---|
| Total | $1, 060, 935 | $985, 769 | $35, 904 | $3, 775 | $17, 713 | $17, 774 | $1, 582 |
| Turkey Foot | 301, 007 | 291, 210 | 6, 413 | 620 | 850 | 1, 914 | 2, 827 |
| Mount Morris | 359, 143 | 337, 114 | 6, 056 | 110 | 863 | 15, 000 | 14, 657 |
| Volcano and Eureka | 395, 310 | 352, 795 | 22, 610 | 3, 045 | 16, 000 | 860 | 720 |
| Burning Springs | 5, 475 | 4, 650 | 825 | ........ | ........ | ........ | 664 |

LABOR AND WAGES.

The total number of employés returned as engaged in the production of crude petroleum in West Virginia at the close of 1889 was 339, who were paid $160,974. The division of these workmen into classes and wages paid is as follows:

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of foremen or overseers | 17 | |
| Total wages paid all workmen of this class in 1889 | .... | $14, 520 |
| Number of mechanics | 213 | |
| Total wages paid all workmen of this class in 1889 | .... | 108, 298 |
| Number of laborers | 107 | |
| Total wages paid all workmen of this class in 1889 | .... | 36, 756 |
| Office force: | | |
| Total number (males) | 2 | |
| Total wages paid (males) | .... | 1, 400 |
| Total number of persons employed and wages paid in 1889 | 339 | 160, 974 |

The character of work for which this total amount of wages was paid is shown in the following table:

WAGES PAID FOR LABOR.

| | |
|---|---|
| In building rigs | $19, 869 |
| In drilling wells | 82, 312 |
| In operating and caring for wells | 55, 903 |
| In torpedoing wells | 30 |
| In building or repairing tankage | 1, 460 |
| In office | 1, 400 |
| Total | 160, 974 |

Following will be found statements showing the statistics of the production of each of the districts in West Virginia.

## TURKEY FOOT DISTRICT.

The statistics of the production of petroleum in the Turkey Foot district in 1889 are as follows:

TOTAL PRODUCTION AND VALUE.

| | |
|---|---|
| Total production in 1889 (barrels of 42 gallons) | 199, 460 |
| Total value at wells of all oil produced, excluding pipage | $243, 192 |
| Value per barrel | $1. 21⅞ |

STOCKS OF OIL ON HAND AT WELLS.

| | BARRELS. |
|---|---|
| December 31, 1888 | 1, 804 |
| December 31, 1889 | 1, 557 |

WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 5 |
| Total number of producing wells December 31, 1889 | 103 |
| Total number of flowing wells December 31, 1889 | 11 |
| Total number of pumping wells December 31, 1888 | 5 |
| Total number of pumping wells December 31, 1889 | 92 |
| Number of wells completed in 1889 | 153 |
| Number of dry holes in 1889 | 40 |
| Number of producing wells completed in 1889 | 113 |
| Initial daily production of new wells (barrels) | 3, 726 |
| Number of rigs building December 31, 1888 | 2 |
| Number of rigs building December 31, 1889 | 11 |
| Number of wells drilling December 31, 1888 | 2 |
| Number of wells drilling December 31, 1889 | 15 |
| Value of materials used in caring for and operating wells in 1889 | $92, 254 |

### CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $489, 180 |
| Number of acres of oil land: | | |
| Owned | 50 | |
| Leased | 32, 295 | |
| Total acreage | 32, 345 | |
| Present value of land, both owned and leased | | 188, 173 |
| Average value per acre, $6. | | |
| Value of rigs, wells, engines, boilers, etc | | $291, 210 |
| Value of tanks | | 6, 413 |
| Value of pipe lines at wells owned by parties making report | | 620 |
| Value of oil in stock at wells December 31, 1889 | | 850 |
| Value of other property and improvements | | 1, 914 |
| Total | | 301, 007 |

### LABOR AND WAGES.

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of foremen or overseers | 5 | |
| Total wages paid all workmen of this class in 1889 | .... | $3, 690 |
| Number of mechanics | 131 | |
| Total wages paid all workmen of this class in 1889 | .... | 79, 065 |
| Number of laborers | 47 | |
| Total wages paid all workmen of this class in 1889 | .... | 16, 971 |
| Office force: | | |
| Total number (males) | 2 | |
| Total wages paid (males) | .... | 1, 400 |
| Total number of persons employed and wages paid in 1889 | 185 | 101, 126 |

| | |
|---|---|
| Wages paid for labor: | |
| In building rigs | $11, 180 |
| In drilling wells | 66, 445 |
| In operating and caring for wells | 20, 661 |
| In building or repairing tankage | 1, 440 |
| In office | 1, 400 |
| Total | 101, 126 |

### CLASSIFIED WAGES.

| CLASS OF LABOR. | Number of each class. | Range of wages. |
|---|---|---|
| Foremen | 5 | $10 to $100 per month. |
| Pumpers or engineers | 24 | $50 to $75 per month. |
| Carpenters | 12 | $2. 50 per day. |
| Rig builders | 42 | $140 to $200 per rig. |
| Drillers | 76 | 60 cents to $1. 40 per foot. |
| Laborers | 18 | $2 per day. |
| Teamsters | 6 | $5 per day. |

### MOUNT MORRIS DISTRICT.

The statistics of the production of petroleum in Mount Morris district in 1889 are as follows:

### TOTAL PRODUCTION AND VALUE.

| | |
|---|---|
| Total production in 1889 (barrels of 42 gallons) | 174, 758 |
| Total value at wells of all oil produced, excluding pipage | $194, 949 |
| Value per barrel | $1. 11½ |

The stock on hand December 31, 1889, amounted to 678 barrels of illuminating oil.

### WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1889 | 23 |
| Total number of flowing wells December 31, 1889 | 3 |
| Total number of pumping wells December 31, 1889 | 20 |
| Number of wells completed in 1889 | 24 |
| Number of dry holes in 1889 | 1 |
| Number of producing wells completed in 1889 | 23 |
| Initial daily production of new wells (barrels) | 3, 298 |
| Number of rigs building December 31, 1888 | 1 |
| Number of rigs building December 31, 1889 | 3 |
| Number of wells drilling December 31, 1889 | 4 |
| Value of materials used in caring for and operating wells in 1889 | $25, 136 |

### CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $501, 254 |
| Number of acres of oil land: | | |
| Owned | 244 | |
| Leased | 49, 063 | |
| Total acreage | 49, 307 | |
| Present value of land, both owned and leased | | 142, 111 |
| Average value per acre, $3. | | |
| Value of rigs, wells, engines, boilers, etc | | $337, 114 |
| Value of tanks | | 6, 056 |
| Value of pipe lines at wells owned by parties making report | | 110 |
| Value of oil in stock at wells December 31, 1889 | | 863 |
| Value of other property and improvements | | 15, 000 |
| Total | | 359, 143 |

### LABOR AND WAGES.

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of foremen or overseers | 4 | |
| Total wages paid all workmen of this class in 1889 | .... | $2, 850 |
| Number of mechanics | 26 | |
| Total wages paid all workmen of this class in 1889 | .... | 15, 331 |
| Number of laborers | 25 | |
| Total wages paid all workmen of this class in 1889 | .... | 7, 272 |
| Total number of persons employed and wages paid in 1889 | 55 | 25, 453 |

| | |
|---|---|
| Wages paid for labor: | |
| In building rigs | $6, 484 |
| In drilling wells | 6, 000 |
| In operating and caring for wells | 12, 969 |
| Total | 25, 453 |

### CLASSIFIED WAGES.

| CLASS OF LABOR. | Number of each class. | Range of wages. |
|---|---|---|
| Foremen | 4 | $75 to $125 per month. |
| Pumpers or engineers | 13 | $40 to $60 per month. |
| Carpenters | 7 | $2 to $2.50 per day. |
| Rig builders | 13 | $150 to $280 per rig. |
| Drillers | 4 | $1.35 to $1.40 per foot. |
| Laborers | 12 | $1.50 to $2 per day. |
| Sundry mechanics | 2 | $60 per month. |

### VOLCANO AND EUREKA DISTRICT.

The statistics of the production of petroleum in Volcano and Eureka district in 1889 are as follows:

### PRODUCTION IN 1889.

| | BARRELS. |
|---|---|
| Illuminating | 142, 133 |
| Lubricating | 23, 602 |
| Total | 165, 735 |

### VALUE AT WELLS OF ALL OIL PRODUCED, EXCLUDING PIPAGE.

| KINDS OF OIL. | Total value. | Value per barrel. |
|---|---|---|
| Total | $211,526 | $1.27⅝ |
| Illuminating | 153,429 | 1.07⅞ |
| Lubricating | 58,097 | 2.46⅛ |

### STOCKS OF OILS ON HAND AT WELLS.

| | BARRELS. |
|---|---|
| December 31, 1888: | |
| Illuminating: | 500 |
| Lubricating | 3,800 |
| Total | 4,300 |
| December 31, 1889: | |
| Illuminating | 500 |
| Lubricating | 4,100 |
| Total | 4,600 |

### WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 493 |
| Total number of producing wells December 31, 1889 | 490 |
| Total number of flowing wells December 31, 1888 | 7 |
| Total number of flowing wells December 31, 1889 | 8 |
| Total number of pumping wells December 31, 1888 | 486 |
| Total number of pumping wells December 31, 1889 | 482 |
| Number of wells completed in 1889 | 29 |
| Number of producing wells completed in 1889 | 29 |
| Initial daily production of new wells (barrels) | 567 |
| Number of rigs building December 31, 1888 | 2 |
| Number of rigs building December 31, 1889 | 2 |
| Number of wells drilling December 31, 1888 | 3 |
| Number of wells drilling December 31, 1889 | 5 |
| Value of materials used in caring for and operating wells in 1889 | $5,379 |

### CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $476,028 |
| Number of acres of oil land: | | |
| Owned | 100 | |
| Leased | 36,495 | |
| Total acreage | 36,595 | |
| Present value of land, both owned and leased | | 80,718 |
| Average value per acre, $2. | | |
| Value of rigs, wells, engines, boilers, etc | | $352,795 |
| Value of tanks | | 22,610 |
| Value of pipe lines at wells owned by parties making report | | 3,045 |
| Value of oil in stock at wells December 31, 1889 | | 16,000 |
| Value of other property and improvements | | 860 |
| Total | | 395,310 |

### LABOR AND WAGES.

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of foremen or overseers | 8 | |
| Total wages paid all workmen of this class in 1889 | | $7,980 |
| Number of mechanics | 56 | |
| Total wages paid all workmen of this class in 1889 | | 13,902 |
| Number of laborers | 32 | |
| Total wages paid all workmen of this class in 1889 | | 11,193 |
| Total number of persons employed and wages paid in 1889 | 96 | 33,075 |

| | |
|---|---|
| Wages paid for labor: | |
| In building rigs | $2,205 |
| In drilling wells | 9,867 |
| In operating and caring for wells | 20,953 |
| In torpedoing wells | 30 |
| In building or repairing tankage | 20 |
| Total | 33,075 |

### CLASSIFIED WAGES.

| CLASS OF LABOR. | Number of each class. | Range of wages. |
|---|---|---|
| Foremen | 8 | $45 to $105 per month. |
| Pumpers or engineers | 28 | $1 to $1.50 per day.<br>$40 to $50 per month. |
| Carpenters | 4 | $2.50 to $3 per day. |
| Rig builders | 18 | $36 to $200 per rig. |
| Drillers | 27 | 65 to 90 cents to $1 per foot. |
| Tool dressers | 2 | $2 to $3 per day. |
| Laborers | 4 | $1.25 to $1.50 per day. |
| Well cleaners | 2 | $5 per day. |
| Sundry mechanics | 3 | $50 per month. |

## BURNING SPRINGS DISTRICT.

The statistics of the production of petroleum in Burning Springs district in 1889 are as follows:

### TOTAL PRODUCTION AND VALUE.

| | |
|---|---|
| Total production in 1889 (barrels of 42 gallons) | 4,160 |
| Total value at wells of all oil produced, excluding pipage | $4,160 |
| Value per barrel | $1 |

There was no stock on hand December 31, 1888 and 1889.

### WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 7 |
| Total number of producing wells December 31, 1889 | 7 |
| Total number of flowing wells December 31, 1888 | 1 |
| Total number of flowing wells December 31, 1889 | 1 |
| Total number of pumping wells December 31, 1888 | 6 |
| Total number of pumping wells December 31, 1889 | 6 |

### CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $6,136 |
| Number of acres of oil land: | | |
| Owned | 2 | |
| Leased | 1,970 | |
| Total acreage | 1,972 | |
| Present value of land, both owned and leased | | 661 |
| Average value per acre, $0.34. | | |
| Value of rigs, wells, engines, boilers, etc | | $4,650 |
| Value of tanks | | 825 |
| Total | | 5,475 |

### LABOR AND WAGES.

| | |
|---|---|
| Total number of persons employed in 1889 | 3 |
| Total wages paid all workmen in 1889 | a$1,320 |

a Paid for operating and caring for wells.

The number of pumpers or engineers employed was 3, whose wages ranged from $10 to $50 per month.

## COLORADO.

Though indications of petroleum, such as oil springs, sandstones impregnated with petroleum or with the residuum after evaporation, and "oozes", are reported from many parts of Colorado, the only locality from which oil has been produced in paying quantities is the field located in the valley of the Arkansas near Florence, in Fremont county, known as the Florence field. This field extends from near Cañon City, 8 miles above Florence, to an as yet undetermined distance southeast of Florence. The present productive field is confined to a small area, about 2 miles square, of the valley of the Arkansas river and adjacent "mesa" or table-land. It is reached by the Denver and Rio Grande and Atchison, Topeka and Santa Fe railroads. The productive wells at present seem to be confined to a basin 1½ to 2 miles wide. East and west of this basin the petroleum is displaced by water. A notable spring of soda water was recently struck about 2 miles east of Florence at a depth of 2,200 feet, the water issuing from the ground at a temperature of 80° F. The length of this basin is northwest and southeast. What its extent is along its length is not as yet determined. The first wells, as will be seen below, were struck near Cañon City, about 8 miles northwest of Florence; but these wells have been abandoned, and all the production is in the immediate vicinity of Florence. The drilling at the present time is chiefly toward the southeast from Florence, toward Pueblo, the larger bodies of land held by the different companies being in this direction. Wells have been bored near Pueblo, about 30 miles down the river, which have yielded water abundantly, but no oil. There is quite a stretch of country just below Florence which has the same geological structure as that in which the wells have been drilled. It is possible that the oil field may extend some distance down the river toward Pueblo.

As stated above, indications of oil have been found in many other places in Colorado. Beneath the Laramie deposit the Colorado group of the cretaceous formation consists of bituminous shales 1,500 to 2,500 feet in thickness. These have been disturbed in the vicinity of the mountains, and gas and oil have been found issuing from them in many places, as on the north branches of the San Juan river, in the coal basin below Glenwood Springs, and in the White River country. These bituminous shales of the Laramie have yielded and probably will still yield large quantities of petroleum. At Morrison, 11 miles from Denver, on the Denver and South Park railroad, the Denver Natural Gas and Oil Company is drilling for oil, encouraged by the presence of a sand rock colored dark brown or black by the residual products of the liquid hydrocarbons, which exists five-eighths of a mile west of the drilling point. The rock outcrops at this point, dipping about 30° east. Drilling was begun five-eighths of a mile east of the outcrop under the supposition that oil would be found at greater quantities at this depth. The drilling is in a shale, and was in May, 1891, down to a depth of 1,950 feet, no oil having been reached at that time. The drilling of this well, known as the Morrison well, has been discontinued.

The first indications of petroleum in Fremont county were found at Oil Springs, about 6 miles northeast from Cañon City and half a mile above the mouth of Oil Creek cañon. Mr. Joseph Lamb and other pioneers claimed to have seen the springs in 1859, but Mr. Gabriel Bowen is generally credited with the discovery. In 1862 the late Mr. A. M. Cassady purchased the springs from Mr. Bowen and in March of the same year began collecting the crude oil by sinking 6 wells, first digging and sinking shafts, following with spring pole and drill to a depth of 60 to 100 feet. 2 wells were sunk from 300 to 500 feet, but oil was only found near the surface.

Between the years 1862 and 1865 Mr. Cassady collected and refined oil, most of which was transported by team and sold in Pueblo, Denver, and Sante Fe. For some of the refined oil he realized as high as $5 per gallon.

As Mr. Cassady's method of refining was crude and expensive, the advent of railroads across the plains from the Missouri river rendered his industry unremunerative and he abandoned it. Other parties at later dates attempted to sink wells in the same locality, but without success.

In 1881, while a well was being drilled near the coal mines at the town of Coal Creek for a water supply, oil was discovered at a depth of 1,260 feet. A company was organized, composed of citizens of Cañon City, called the Land Investment Coal and Oil Company, which commenced operations in November, 1882, and on April 7, 1883, after expending about $20,000, struck oil on the farm of Mr. Edwin Lobach, near the town of Florence, the present center of the oil industry of Colorado. This company was not successful, and in a few years was merged into the Colorado Oil Company, which company, with the Arkansas Valley Oil and Land Company and other interests, organized the United Oil Company in 1887.

Other operations since the organization of the United Oil Company have been undertaken at Florence. The only one, however, operating in the census year was the Florence Oil and Refining Company. These 2 companies produced all the oil from this district in 1889. 4 other companies, however, have since begun operations in this field, namely, the Rocky Mountain Oil Company, Triumph Oil Company, Colorado Coal and Iron Company, and the Beaver Land Company.

The geology of the country near Florence is very simple. The Arkansas valley at Florence has cut through the Laramie group, the upper member of the cretaceous, exposing the upper portion of the Colorado group, the middle member of the cretaceous. East and west of Florence the rocks of the Laramie, sandstones and shales, with beds of coal lying nearly horizontal, are exposed on the mountain side. In the valley at Florence, where the wells have been put down, the formation consists almost entirely of blue or bluish-black shale, having a thickness of from 3,000 to 4,000 feet. The wells are all sunk in this shale, no well that has yet been put down having passed through it, though some wells have been drilled 3,500 feet or more. Farther up the valley of the Arkansas these sedimentary strata are uplifted and rest against a granite axis of the Greenhorn range. The slate or shale in which the oil is found dips southwest about 10°. As stated above, the wells drilled in this district have never gone through the shale, which lies just below the drift, but it is questionable if the origin of the oil is in the shale. The indications are that it drains into the shale probably from the direction of Cañon City. It is noted in drilling that when the shale seems to be solid and unbroken no oil is found, but when in drilling crevices are struck and the strata appears broken oil is almost sure to be discovered. A well at a given point, which, when drilled, shows crevices and broken strata, may produce 150 to 200 barrels a day, while another well 100 feet from it, drilled through solid shale, will not give the least indication of oil. About 1 well in 3 has proved a producer.

The depth at which oil is found varies greatly. There are producing wells as deep as 1,960 feet, and others not over 1,000 feet. In one case there are 2 wells within 300 feet of each other, in one of which oil was found at a depth of 1,630 feet, and in the other no oil was found until 1,960 feet had been reached. The earlier wells of the Florence field were drilled 1,000 to 1,200 feet. In many cases these wells, after producing for awhile, ceased, but upon drilling deeper they began producing again. No water is found in the wells after leaving the surface.

It will thus be seen that the conditions under which oil is found in Colorado are very different from those of its occurrence in Pennsylvania and Ohio. There are no pools as the word is understood in the east, but the oil seems to flow through the crevices or shattered strata to the drill hole. It is also a remarkable fact that the wells, instead of decreasing, actually increase in production. A certain well on the property of one of the companies, which began producing 90 barrels of oil, now produces 150, the maximum being reached within a short time after the well was struck, it gaining every day for about 2 weeks. Another well that began with a production of 100 barrels ran up in 5 days to 210, and has been producing at this rate for months. On the other hand, sometimes increase in production is very gradual, wells that are now several years old having recently increased their production. One well that started off producing 40 barrels in this way has recently run up to 150. The life of wells in the Florence district is also very long, and some wells have been remarkable producers, one having produced up to May 1, 1891, over 6,000,000 gallons. The large production and long life of the wells of this district may be due to the fact that it is a new field and comparatively few wells have as yet been put down.

It is also a fact that it does not hurt these wells to shut them down for a period. Often when the demand for oil has not been equal to the production the wells have been shut in, starting off again with full production when pumped. This will account for the variation in the number of producing wells shown in the table given elsewhere. This variation is not due to the drilling of new wells and the abandonment of old, but to stopping of production by shutting in the wells.

The Florence oil has a number of peculiarities as compared with Pennsylvania. It is a heavy oil, being about 31° B. It contains little or no lighter hydrocarbon, all the products that pass over in refining being sold as illuminating oil. Nor does the oil deposit any B. S. It yields in refining about 35 to 44 per cent water-white illuminating oils of about 125° fire test.

There is little or no market for the residuum from refining other than for fuel, for which purpose it is sold at 25 cents a barrel. The demand for this purpose has not been equal to the supply; it is run into a depression near the refinery in such quantities that it has formed a lake of petroleum residuum.

### PRODUCTION.

The following table gives the total production of all Colorado oil wells for the year 1889, and includes all oil paid as royalty to owners of land upon which wells were drilled. There is no market in Colorado for crude oil, and none is bought and sold except a very small amount of royalty oil, which is pumped and bought by refineries and is paid for at the rate of 2 cents per gallon or 84 cents per barrel.

PRODUCT OF CRUDE OIL IN COLORADO IN 1889.

| | BARRELS. |
|---|---|
| January | 27,270 |
| February | 26,120 |
| March | 25,845 |
| April | 17,229 |
| May | 20,550 |
| June | 18,837 |
| July | 23,360 |
| August | 27,561 |
| September | 28,071 |
| October | 32,289 |
| November | 34,774 |
| December | 34,570 |
| Total | 316,476 |
| Total value at wells of all oil produced | $280,240 |

### STOCK OF CRUDE OIL AT WELLS.

|  | BARRELS. |
|---|---|
| 1888. |  |
| December 31 | 13,092 |
| 1889. |  |
| January 31 | 10,870 |
| February 28 | 24,496 |
| March 31 | 34,792 |
| April 30 | 39,593 |
| May 31 | 41,883 |
| June 30 | 41,953 |
| July 31 | 38,355 |
| August 31 | 40,516 |
| September 30 | 35,519 |
| October 31 | 38,418 |
| November 30 | 40,854 |
| December 31 | 51,034 |
| Average | 36,524 |
| Value of stock on hand at wells December 31, 1889 | $45,267.56 |

The value of these stocks is calculated on the same basis as that of production.

### DISTRIBUTION OF PRODUCT.

There are no pipe lines or distribution lines used in Colorado. All oil produced is consumed by refineries. The per cent of oil evaporated is very small.

### DISTRIBUTION OF THE COLORADO OIL PRODUCT.

|  | BARRELS. |
|---|---|
| Stocks at wells December 31, 1888 | 13,092 |
| Produced in 1889 | 316,476 |
| Total | 329,568 |
| Stock December 31, 1889 | 51,034 |
| Distribution in 1889: |  |
| Dump oil | 277,211 |
| Evaporated | 1,323 |
| Remaining on hand December 31, 1889 | 51,034 |
| Total | 329,568 |

### TOTAL NUMBER OF RIGS BUILDING BUT NOT COMPLETED.

[No rigs building in months omitted in 1889.]

|  |  |  |  |
|---|---|---|---|
| December 31, 1888 | 3 | July 31, 1889 | 1 |
| January 1, 1889 | 2 | August 31, 1889 | 1 |
| February 28, 1889 | 1 | September 30, 1889 | 1 |

Total value of materials used in building rigs, $3,600.

### TOTAL NUMBER OF RIGS COMPLETED.

[No rigs completed in months omitted in 1889.]

|  |  |  |  |
|---|---|---|---|
| During— |  | During— |  |
| January, 1889 | 3 | July, 1889 | 1 |
| February, 1889 | 2 | August, 1889 | 1 |
| March, 1889 | 1 | September, 1889 | 1 |

Total cost of rigs built in 1889, $7,200.

### TOTAL NUMBER OF WELLS DRILLING.

[No wells drilling in months omitted in 1889.]

|  |  |  |  |
|---|---|---|---|
| December 31, 1888 | 4 | July 31, 1889 | 2 |
| January 31, 1889 | 3 | August 31, 1889 | 2 |
| February 28, 1889 | 1 | September 30, 1889 | 2 |

Total value of materials used in drilling wells, $27,500.

Where dry holes have been drilled it frequently occurs that the rig is removed and another well started, thus reducing the cost of the following well.

The value of materials used in drilling wells is that of the tools and fixtures necessary to drill wells, and is not the value of materials used within the wells, such as tubing, casing, rods, etc.

OIL WELLS COMPLETED IN COLORADO IN 1889.

| MONTHS. | Total number of wells completed in each month. | Number of dry holes. | Number of wells producing. | Initial daily production of new wells. (Barrels.) |
|---|---|---|---|---|
| Total | 14 | 8 | 6 | 260 |
| January | 4 | 3 | 1 | 8 |
| February | 3 | 2 | 1 | 50 |
| March | 1 | ........ | 1 | 50 |
| April | ........ | ........ | ........ | ........ |
| May | ........ | ........ | ........ | ........ |
| June | ........ | ........ | ........ | ........ |
| July | ........ | ........ | ........ | ........ |
| August | 2 | 1 | 1 | 90 |
| September | 2 | 1 | 1 | 12 |
| October | 1 | ........ | 1 | 50 |
| November | 1 | 1 | ........ | ........ |
| December | ........ | ........ | ........ | ........ |

Out of 14 wells completed it will be noticed that 8 were dry holes, 6 only being productive. The average initial production of wells was 43⅓ barrels for the first 24 hours.

NUMBER OF PRODUCING OIL WELLS IN COLORADO.

| MONTHS. | Total number producing. (a) | Total number abandoned. | MONTHS. | Total number producing. (a) | Total number abandoned. |
|---|---|---|---|---|---|
| Total | ........ | 6 | 1889. | | |
| | | | May 31 | 16 | ........ |
| 1888. | | | June 30 | 15 | ........ |
| December 31 | 23 | ........ | July 31 | 22 | ........ |
| 1889. | | | August 31 | 23 | ........ |
| January 31 | 24 | ........ | September 30 | 24 | ........ |
| February 28 | 25 | ........ | October 31 | 24 | 1 |
| March 31 | 25 | 1 | November 30 | 23 | ........ |
| April 30 | 12 | 3 | December 31 | 22 | 1 |

*a* All pumping.

Some wells, although productive, were shut down during the year on account of lack of storage and limited demand for crude product at the refineries. 6 wells that had ceased to produce were cleaned, but without results. 13 other wells were cleaned with good results, bringing the production back to almost the original amount. No wells were torpedoed in this state during 1889.

## TANKAGE.

The tankage in this state consists chiefly of cement and brick cisterns, it having been demonstrated that evaporation is less than if wood or iron tankage were used.

STATISTICS OF OIL TANKS IN COLORADO.

| NUMBER. | SIZE. | | | | Material. | Capacity. (Barrels of 42 gallons.) |
|---|---|---|---|---|---|---|
| | Diameter. | | Height. | | | |
| | *Ft.* | *In.* | *Ft.* | *In.* | | |
| 1 | 20 | 2 | 13 | 0 | Cement and brick | 672 |
| 1 | 25 | 0 | 12 | 0 | ....do | 1,000 |
| 1 | 25 | 0 | 13 | 9 | ....do | 1,086 |
| 13 | 31 | 8 | 9 | 6½ | ....do | 1,258 |
| 1 | 30 | 0 | 13 | 4 | ....do | 1,511 |
| 1 | 28 | 7 | 15 | 5 | ....do | 1,581 |
| 1 | 30 | 0 | 22 | 0 | Iron | 2,770 |
| 1 | 59 | 11 | 28 | 0 | ....do | 14,204 |
| 1 | 86 | 0 | 17 | 6 | ....do | 18,105 |
| 7 | ........ | ........ | ........ | ........ | Wood | 37 |
| 15 | 10 | 0 | 8 | 0 | ....do | 100 |

### TANK RECORD.

| | |
|---|---|
| Total number of tanks | 43 |
| Total capacity of tanks (barrels) | 42,324 |
| Total value of materials used in building or repairing tanks in 1889 | $9,039 |
| Total value of all materials used in building or repairing tank cars in 1889 | $7,000 |
| Total length of pipe lines at wells, not including that belonging to pipe-line companies (feet) | 39,228 |
| Total value of pipe lines at wells | $7,904 |
| Sizes of pipe used and length of each size: | |
| 3-inch pipe (feet) | 8,781 |
| 2-inch pipe (feet) | 29,724 |
| 1-inch pipe (feet) | 723 |

The amount of money expended for tankage at wells is really an expense for storage, and includes a limited amount of expense incurred from pipe lines at wells to refineries and storage cisterns.

The condensed statistics of the production of petroleum in Colorado in 1889 are as follows:

### TOTAL PRODUCTION AND VALUE.

| | |
|---|---|
| Total production in 1889 (barrels of 42 gallons) | 316,476 |
| Total value at wells of all oils produced, excluding pipage | $280,240 |
| Value per barrel | $0.88½ |

### STOCKS OF ILLUMINATING OILS ON HAND AT WELLS.

| | BARRELS. |
|---|---|
| December 31, 1888 | 13,092 |
| December 31, 1889 | 51,034 |

### WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 23 |
| Total number of producing wells December 31, 1889 | 22 |
| Total number of pumping wells December 31, 1888 | 23 |
| Total number of pumping wells December 31, 1889 | 22 |
| Number of wells completed in 1889 | 14 |
| Number of dry holes in 1889 | 8 |
| Number of producing wells completed in 1889 | 6 |
| Initial daily production of new wells (barrels) | 260 |
| Number of rigs building December 31, 1888 | 3 |
| Number of wells drilling December 31, 1888 | 4 |
| Value of materials used in pumping, caring for, and operating wells in 1889 | $27,500 |

### CAPITAL INVESTED IN COLORADO OIL FIELDS.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $3,000,000 |
| Number of acres of oil land: | | |
| Owned | 33,015 | |
| Leased | 6,100 | |
| Total acreage | 39,115 | |
| Present value of land, both owned and leased | | 2,517,215 |
| Average value per acre, $64. | | |
| Value of rigs, wells, engines, boilers, etc | | $229,659 |
| Value of tanks | | 63,581 |
| Value of tank cars | | 8,333 |
| Value of pipe lines at wells owned by parties making report | | 7,903 |
| Value of oil in stock at wells December 31, 1889 | | 45,268 |
| Value of other property and improvements | | 128,041 |
| Total | | 482,785 |

### LABOR EMPLOYED IN PRODUCING COLORADO OIL.

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of foremen or overseers | 5 | |
| Total wages paid all workmen of this class in 1889 | | $4,950 |
| Number of mechanics | 56 | |
| Total wages paid all workmen of this class in 1889 | | 19,138 |
| Number of laborers | 28 | |
| Total wages paid all workmen of this class in 1889 | | 8,744 |
| Office force: | | |
| Total number (males) | 1 | |
| Total wages paid (males) | | 1,800 |
| Total number of persons employed and wages paid in 1889 | 90 | 34,632 |

### WAGES PAID IN PRODUCING COLORADO OIL.

| Wages paid for labor: | |
|---|---|
| In building rigs | $2,703 |
| In drilling wells | 8,099 |
| In operating and caring for wells | 21,494 |
| In building and repairing pipe lines | 536 |
| In office | 1,800 |
| Total | 34,632 |

### CLASSIFIED WAGES.

| CLASS OF LABOR. | Number of each class. | Range of wages. | Average. | Days employed. |
|---|---|---|---|---|
| Foremen | 4 | $4.17 to $5 per day | $4.58 | 330 |
| Pumpers or engineers | 20 | $2.50 per day | 2.50 | 145 |
| Carpenters | 10 | $3 per day | 3.00 | 86 |
| Drillers | 8 | $4 per day | 4.00 | 127 |
| Tool dressers | 10 | $3 per day | 3.00 | 112 |
| Laborers | 38 | $2 per day | 2.00 | 115 |

## CALIFORNIA.

The petroleum fields of California where oil is found in merchantable quantities are almost exclusively within the boundaries of the southern counties, though oil has been found in many other parts of the state.

The oil-producing territory in California in 1889 may be divided into two general sections: (1) that included in the Santa Paula region, in which are found the Ojai, Sespe, Ex-Mission (which includes the Adams and other districts), the Torrey cañon in the San Fernando mountain, 22 miles west of Newhall, the San Fernando district, including the Pico, Wiley, and Elsemere fields, and the Puente district, in which only one field, the Puente, is found; (2) the Santa Clara district, in Santa Clara county, which is known sometimes as Moody Gulch.

The wells in the Santa Paula subdistrict of the southern fields are in Ventura county; the Pico and Puente subdistricts are in Los Angeles county.

Oil was at one time produced in San Mateo county, a short distance below San Francisco on the coast, and small amounts in other counties; but the only production in 1889 was in Santa Clara, Ventura, and Los Angeles counties.

The oil belt commences near Santa Paula, in Ventura county, and extends thence in a southeasterly direction about 80 miles to Puente, in Los Angeles county, taking in the Sespe, Torrey Cañon, and other wells in Ventura county, Pico, Newhall, Elsemere, Puente, and other districts in Los Angeles county. This belt has a variable width of from 2 to 3 miles, though oil is not found all through the entire length, it being apparently in pools.

Though petroleum has been known to exist in California from the time of its first settlement by the whites, no attempt was made to utilize the deposits until about the time of the discovery of the Pennsylvania oil fields, which led to the prospecting for petroleum at localities pointed out by petroleum and tar springs and by seepage from the asphaltum beds. During the years 1865 and 1866 upward of 70 companies were incorporated in California to search for petroleum and a large amount of money was spent, but no considerable amount of oil was found. The developments at this date were in Los Angeles and Ventura counties.

Discouraged at the result of the first efforts, but little was done until 1875, when the business began to revive. In this year 2 wells were put down in the Pico cañon, which have been producers ever since. These two wells produced in 1875 about 650 barrels of oil. In 1877 6,332 barrels were produced from the Ex-Mission field, and in 1878 300 barrels were produced from the Santa Clara district.

The first wells put down in the Pico cañon were drilled with spring poles. At least 3 wells were drilled in this way, 2 of which are still producing.

The petroleum fields of California are the most interesting in the United States. In many respects they differ entirely from any other fields yet opened. The oil, with the exception of that from Santa Clara, has usually, as its "base", asphaltum instead of paraffin. The Pacific Coast Oil Company at one time pressed paraffin wax from the Santa Clara oil, but the low price of the wax and the reduction in the production of the crude compelled them to discontinue this production. The strata in which the oil is found are tilted at a high angle. Drilling is difficult and expensive, owing to the character of the rock and angle at which the oil-bearing strata stand. The oil, while carrying but a small proportion of the illuminating hydrocarbons, finds a ready market as fuel, owing to the high price of coal in California, and it contains practically no B. S.

While there is a certain general resemblance in all of the southern fields, there are certain important differences which make a description of each field of importance.

Describing the most northwesterly, the Santa Paula, first, it may be said that this field includes, as has been stated above, a number of small subdivisions, such as the Ex-Mission, Adams, Sespe, Ojai, Santa Paula, Torrey cañon, and others. These cañons are sharp ravines cut laterally in the sides of the mountains and usually at right angles with the course of the range. The strata in these various districts stand at an angle of about 75°. In sinking wells the drills pass through shales until the oil sand is struck, which is from 2 to 40 feet in thickness. This sand is believed to be in the tertiary, though of this there is some doubt. A red sand that used to be regarded as barren is now giving some very good wells.

The great angle at which the strata stand in this district makes drilling exceedingly difficult, resulting often in crooked holes, causing the drills to lodge in the wells and requiring torpedoing and reaming out and very expensive work in recovering them. This liability of the wells to become crooked suggested the employment of the diamond drill in boring. A well was bored in this way at Pico, but it was not a success, though a straight hole was secured. The fine mud that results from the use of the diamond drill seemed to fill up the interstices in the rock and prevented production. The reaming out of the well by a drill resulted in a very largely increased production. The same fact regarding the tilting strata also suggested the use of tunnels in producing petroleum. Indeed, some of the earliest work in mining for petroleum in California was by the use of tunnels. In fact, in the early history of this field and of all southern California prospecting for petroleum was by these tunnels, which were driven into the sides of the mountains where the surface indications, such as tar springs or seepage from asphaltum deposits, gave any prospect of getting oil. Many of these tunnels are still in existence and some are producing. One of these tunnels was driven in 1864 by a company of which Senator Stanford was a member. This produced at first 25 barrels of oil a day. Twelve years later the production had fallen to 8 barrels a day, and when Messrs. Hardison & Stewart purchased the property, in 1885, it was producing 5 barrels a day, and at the present time 2 barrels a day.

This method of producing oil has never been in great favor in California. It is somewhat dangerous, as is all tunneling. It is known locally as "coyoting". There are many things, however, to commend it for these fields. As suggested above, the difficulty and expense of drilling, and especially the caving in of the wells, owing to the peculiar structure of the shale through which the wells are drilled, makes it difficult and expensive, not only to put down wells, but to case off the water. In these tunnels there is no caving in of strata, no casing, no pumping, and, in fact, no expense after the tunnel is once driven.

The first or Stanford tunnel was driven 350 feet. One driven some 4 years ago was 625 feet long. The oil was found in different strata, and paid for it before it was finished. The yield of this tunnel was about 60 barrels a day when first finished; now it is 8 barrels a day. The cost of driving these tunnels is from $5 to $10 a running foot. The wells cost as much as this at times. The size of the tunnel is usually 4 by 6 feet. In 1889 there were 4 of these tunnels producing.

Another peculiarity of these wells, growing out of the tilting of the strata above referred to, is the great increase in the production of different wells put down to reach the strata at different depths. As has already been stated, these strata dip about 75°. A series of 5 wells has been put down at one place in the Adams cañon, the wells being started on the surface at different heights up the mountain side above the stream at its base. The first well was put down a short distance above the point where the oil-bearing rock came to the surface, the presence of the oil showing itself by seepage from the outcropping rock. The sand rock was struck at a depth of 110 feet and produced 20 barrels a day. The second well was started a little higher up the mountain side, the rock pitching toward the mountain, striking the oil-bearing rock at a depth of 130 feet, giving a production of 25 barrels a day, draining or, perhaps better, stopping production entirely in No. 1. A third well was started still farther up the mountain side, which struck the rock at a depth of 330 feet, producing 75 barrels a day and stopping production in the second well. A fourth well, started still higher up the mountain side, struck the rock at a depth of 682 feet and started off producing 300 barrels a day, stopping production in No. 3. The fifth well is being put down very much higher up the mountain, but had not struck the sand rock at the time this report closed, though it had been drilled to a depth of 2,450 feet. The fourth well described above produced up to a given period 123,000 barrels, the production of the 4 wells being for the same time 250,000 barrels.

Another peculiarity is noticed in these wells. Sometimes the depth of shale is very slight, the well being drilled entirely through sand (not sand rock), a little oil being produced all the way down. It is customary to case the well and perforate the casing, the oil flowing in from the sand almost the entire depth of the well. In a short time, however, the sand packs around the casing, the oil begins to percolate through it, and, to use the expression of the region, the well "gets its pace and is a stayer".

The oil of the Santa Paula field produces about 15 per cent of distillate; 35 per cent can be secured, but the quality of the illuminant is not satisfactory. But little oil from this district is refined, most of it being sold for fuel purposes. The gravity is from 16° to 32°, the average being about 26°. The oil from the same region differs greatly in its character. In putting down wells up the sides of a hill 6 or 7 different grades of oil will be found in as many ledges. In one case 6 wells were put down, beginning at the bottom of the hill and going up the sides 400 feet. In the first well going up the hill a black oil of 26° gravity was found; in the second well the oil was black and of 28° gravity; in the third it was a heavy oil and brown; in the fourth well the oil was 18° gravity, tarry and black; in the fifth well the gravity was 18°, heavy and green, and in the sixth well the gravity was 30° and the oil was light green in color with some yellow.

The strata in the other districts are not pitched as in the Santa Paula, where they stand at an angle of some 75°. In the Pico field they are 65°, and in the Puente 30°. This excessive tilting makes drilling difficult and expensive.

Not only are the strata very much tilted, but they are so much so all through southern California that but little dependence can be placed in their continuity. This resulted in the early history of mining for oil in California in the spending of very large sums of money, but with very little result, but in later years it has led to very cautious explorations. It also has resulted in very small fields, with the exception of the Santa Paula. In this field there are practically continuous deposits for a distance of some 40 miles, though the deposits are in pools. The Pico producing field is but a few hundred feet, possibly a mile in length by 700 or 800 feet broad, though developments are being made for 8 miles, while the Puente, as developed, is but 3,500 feet long by 800 feet broad. This also is probably much larger.

Many of the conditions existing in the Pico cañon are similar to those in the Santa Paula district; but there are a number of conditions that are more manifest here than in Santa Paula. The San Fernando district, as stated above, comprises three subfields, the Pico, which is the most important, the Wiley, and the Elsemere, which are recent developments. The Pico field is some 7.5 miles west of Newhall, which is on the Southern Pacific railroad; the Wiley some 5.5 miles southwest, and the Elsemere 2.5 miles to the southeast. These are all connected with Newhall by pipe lines.

As has already been stated, drilling was begun in this field in 1875, August 22 being the date of the beginning of the first well, which was finished September 8. This well was drilled to a depth of 120 feet with a spring pole. At the depth of 30 feet oil was struck in a shale, giving a production of 2 barrels a day. At the depth of 120 feet oil was found, also in shale, the production being 10 to 12 barrels a day. In 1887 this well was deepened with modern drilling tools to a depth of 600 feet. At a depth of 175 feet the well produced by pumping 30 barrels a day. In 1882 this well was still further deepened to 735 feet, but there was no increase in production. The best sand was found in this well at a depth of 170 feet. Well No. 2, very close to No. 1, was drilled in November, 1875, also with a spring pole. The best sand was struck at a depth of 250 feet, the well flowing from 20 to 25 barrels a day. At 520 feet the production was 40 barrels, the well being pumped. In well No. 3 sand producing 4 barrels a day was struck at 90 feet, another at 145 feet producing 8 barrels a day, while at 170 feet one producing 11 barrels a day was struck. In well No. 5 the first oil-producing sand was struck at 900 feet, while in No. 7 sand was found at 850 feet, giving a flowing well. The deepest producing wells in this district are from 1,400 to 1,730 feet.

The same difficulty in drilling wells exists here as in the Santa Paula district. The wells are put down on the sides of very steep cañons, requiring very expensive work in securing a level place to begin drilling, oftentimes requiring blasting in the mountain side. Crooked holes are not infrequent, and it is nothing uncommon for wells to cost from $6,000 to $20,000 apiece. Contracts have been taken in this district to put down wells at $6 a foot, the company owning the land furnishing fuel, water, and casing.

The wells in this district never suffer from drowning out by water. Though some of the wells produce both water and oil. The average proportion of water to oil is very small. In some wells the water contains material in solution that eats the casing, making it thin, like paper. In this district, as in others, considerable gas is found in the wells, which is utilized for pumping and drilling, saving possibly in this district 20 tons of coal a day. Wells are never shot for production. Sometimes when a hole is crooked and tools are stuck in them they are shot to release the tools, but not to increase the yield of oil.

The oil of the Pico field is in some respects better than that of the other fields, some of it containing a little paraffin occasionally, and it yields a larger percentage of illuminants in refining than the Santa Paula oil, crude being about 40° gravity.

In the Wiley subdivision of the Pico field two different oils are found, taken from the same well, a green and a black. The production of these two oils is about 4½ barrels a day, and was found at a depth of from 600 to 800 feet. In drilling this well sand, not sandstone, was struck at a depth of from 400 to 600 feet. This sand followed the drill up the well fully 50 feet. It is from this sand that the oil comes. It had to be shut off from the well by casing and the casing perforated. A similar phenomenon is noticed in the Santa Paula district.

The Elsemere field was not developed until after the close of 1889.

The Puente field is located in the Puente hills, 7 miles from Puente station, on the Southern Pacific railroad. Oil in some instances is found in a shale just above the sand, but mostly in the sand. It has asphaltum as its base, carrying about 15 per cent. Wells are struck at various depths, but the best producers begin at 500 feet. It is difficult to drill below 1,200 feet, owing to the caving in of the strata, noticed in connection with the remarks on other fields. One well has been drilled in this district to a depth of 1,200 feet, but the deepest producer is at 1,000 feet.

The strata are very much pitched and broken, dipping about 30° north, the strike being a little northwest of west. The field as at present developed is 3,500 feet long by 800 feet wide.

The first well was drilled in this field in 1883. The occasion of drilling the well was the discovery of a large amount of seepage near where the well was first put down. No. 2 and No. 3 were drilled early in 1884, and no others were drilled until 1886. The earlier wells up to No. 3 were drilled to the depth of 200 feet, and produced a heavy oil to the amount of 3 or 4 barrels a day. These are still producing, but in smaller amounts, from 1 to 2 barrels daily. No. 4 well, which was drilled in 1886, was also a small producer, yielding 15 barrels a day. No. 5, drilled in 1886, began with a production of 75 barrels. 3 wells were drilled in 1888 and 3 in 1889. The same difficulty in drilling noted in other districts in this state obtain here also, such as crooked holes, caving in of sides, losing of tools, etc. The cost of drilling is from $3 to $6 a foot or more. In this district what is known as stovepipe casing is used. This is a thin riveted casing, two joints being put together, one being smaller than the other. The inner casing on one end projects beyond the outer casing, while the outer casing projects at the other end beyond the inner, forming a socket at one end, into which the projection at the other fits. The casing is ticked together at the joints, requiring no nuts or screws or couplings. The casing is sometimes jacked down into place. All of the oil from this district is piped over the hills to near the Puente station, loaded in tank cars and sent to Los Angeles, and consumed for fuel.

No dry holes have ever been found in this district. Every well that has ever been sunk was a producer and is still producing. The wells are all pumped by heads. Though 1 or 2 spouters have been struck, they soon dropped in production and are now pumping.

The following is an analysis of various tests made of the oil from these wells, having a gravity of 32°:

ANALYSIS OF OIL FROM THE PUENTE FIELD, CALIFORNIA.

| | PER CENT. |
|---|---|
| Benzine, from 80° to 58° | 15 |
| Illuminating, 58° to 42° | 26 |
| Lubricating, 42° to 30° | 14 |
| Lubricating, 30° to 24° | 27 |
| Asphalt (maltha) | 18 |
| Total | 100 |

## STATISTICS OF PRODUCTION OF PETROLEUM IN CALIFORNIA IN 1889.

In the table given below are the consolidated statistics of the production of petroleum in California in 1889. From this it appears that the total production was 303,220 barrels, of which 97,264 barrels were classed as illuminating and 205,956 barrels as fuel oil. The probability is that a small proportion of that oil classed as fuel oil was also sold to refineries, but the division named is the best that was possible under the circumstances. The illuminating oil was priced at $1.25⅛ per barrel at the well, the fuel at $1.13¾. Some of this oil classed as fuel oil was a very heavy oil carrying a large percentage of asphaltum, and was sold as a paint for painting iron pipes. A small portion of the oil classed as illuminating was sold for mixing with asphaltum for thinning or tempering it, as it is termed. This oil brought 20 cents a gallon. These amounts in each case, however, were so small that they may be ignored and the classification allowed to stand.

PRODUCTION OF OILS IN 1889.

| | BARRELS. |
|---|---|
| Illuminating | 97, 264 |
| Fuel | 205, 956 |
| Total | 303, 220 |

VALUE AT WELLS OF ALL OIL PRODUCED, EXCLUDING PIPAGE.

| KINDS OF OIL. | Total value. | Value per barrel. |
|---|---|---|
| Total | $356, 048 | $1. 17⅜ |
| Illuminating | 121, 684 | 1. 25⅛ |
| Fuel | 234, 364 | 1. 13¾ |

Concerning the other statistics but little need be said. It has been exceedingly difficult to collect these figures, and even now there is some doubt as to their accuracy. The business of producing crude petroleum in southern California is so complicated in certain fields as to lead to possible duplication of returns in some instances and to insufficient returns in others. It is believed, however, that the statements given in this report are nearer correct than those usually published regarding the production of crude oil in California, being the result of a personal visit by the special agent to the field.

## STOCKS OF OIL ON HAND AT WELLS.

| | BARRELS. |
|---|---|
| December 31, 1888: | |
| Illuminating | 1, 758 |
| Fuel | 5, 789 |
| Total | 7, 547 |
| December 31, 1889: | |
| Illuminating | 1, 264 |
| Fuel | 2, 176 |
| Total | 3, 440 |

## WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 88 |
| Total number of producing wells December 31, 1889 | 89 |
| Total number of pumping wells December 31, 1888 | 88 |
| Total number of pumping wells December 31, 1889 | 89 |
| Number of wells completed in 1889 | 10 |
| Number of dry holes in 1889 | 4 |
| Number of producing wells completed in 1889 | 6 |
| Initial daily production of new wells (barrels) | 76 |
| Number of rigs building December 31, 1888 | 2 |
| Number of rigs building December 31, 1889 | 1 |
| Number of wells drilling December 31, 1888 | 3 |
| Number of wells drilling December 31, 1889 | 2 |
| Value of materials used in caring for and operating wells in 1889 | $51, 680 |

## CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $2, 186, 958 |
| Number of acres of oil land owned | 10, 607 | |
| Present value of land | | 1, 060, 000 |
| Average value per acre, $100. | | |
| Value of rigs, wells, engines, boilers, etc | | $840, 164 |
| Value of tanks | | 11, 250 |
| Value of tank cars | | 40, 000 |
| Value of pipe lines at wells owned by parties making report | | 61, 257 |
| Value of oil in stock at wells December 31, 1889 | | 4, 036 |
| Value of other property and improvements | | 170, 251 |
| Total | | 1, 126, 958 |

## LABOR AND WAGES.

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of foremen or overseers | 5 | |
| Total wages paid all workmen of this class in 1889 | | $8, 000 |
| Number of mechanics | 25 | |
| Total wages paid all workmen of this class in 1889 | | 18, 147 |
| Number of laborers | 62 | |
| Total wages paid all workmen of this class in 1889 | | 46, 284 |
| Office force: | | |
| Total number (males) | 3 | |
| Total wages paid (males) | | 2, 625 |
| Total number of persons employed and wages paid in 1889 | 95 | 75, 056 |

| | |
|---|---|
| Wages paid for labor: | |
| In building rigs | 3, 195 |
| In drilling wells | 20, 131 |
| In operating and caring for wells | 49, 055 |
| In building or repairing tankage | 50 |
| In office | 2, 625 |
| Total | 75, 056 |

## CLASSIFIED WAGES.

| CLASS OF LABOR. | Number of each class. | Range of wages. |
|---|---|---|
| Foremen | 6 | $100 to $200 per month. |
| Pumpers or engineers | 9 | $65 to $80 per month. |
| Carpenters | 7 | $3 to $4 per day. |
| Drillers | 18 | $3 to $4 per day. |
| Laborers | 58 | $1.50 to $3 per day. |
| Sundry mechanics | 2 | $2.50 to $4 per day. |

## INDIANA.

Although reports of the discovery of oil in Indiana were rife in 1889, the only production in this state concerning which statistics have been secured was at Terre Haute, in Vigo county, and at Montpelier, Blackford county. The notable developments in Indiana have all been subsequent to that year.

On May 6, 1889, oil was struck in the Diall well at Terre Haute. The flow was estimated at 1,000 barrels per day, but its production rapidly declined, the total production for the 8 months after the well was struck being but 30,000 barrels, an average for the entire time of 3,750 barrels a month, or about 125 a day. At the close of the year it was estimated that the production did not exceed 75 barrels a day. The excitement following this find, which was in some respects unlucky, was intense. Company after company was formed, and over $60,000 was expended in exploiting for oil. Up to the close of the year only one producing well in addition to the Diall had been struck. This was a small producer, rated at first as a 50-barrel well, but averaging in December only 15 barrels a day. The oil in these wells is found in the upper part of the Hamilton limestone at a depth of 1,615 feet. The other locality in which oil was found in 1889 was in Montpelier, Blackford county. During that year two wells were drilled at this point. The well drilled by the citizens of the place as a company was intended to demonstrate the presence of oil or gas, and, finding oil, the well was plugged and as late as April, 1891, no use had been made of the product. A well was also drilled at the same place by a firm composed of residents of Montpelier and some oil was secured. The production in 1889, however, was very small. This product is used on the spot for burning under a boiler at a stone quarry, and occasionally a tank car is sold to one of the fuel companies. In this case the price of Lima crude controls the market. The oil is of a dark color, is supposed to be a limestone oil, but has not the sulphurous odor peculiar to the limestone oil from Lima. At the close of the year developments were being pursued in this district with good prospects of securing a supply of oil. Some interest was also being taken in a territory at Keystone, Wells county, 3 miles north of Montpelier, in a section which it was assumed was a continuation of the Montpelier district, and in 1890 some wells were struck and the district gave great promise of becoming an important one in the future.

At Dundee, Madison county, about 6 miles west of Montpelier, and at Bryant, southeast of Montpelier, there are also indications of oil. This whole territory can be named the Montpelier district, from the point at which oil was first struck.

The statistics of the production of petroleum in Indiana in 1889 are given as follows:

### TOTAL PRODUCTION AND VALUE.

| | |
|---|---|
| Total production in 1889 (barrels of 42 gallons) | 33, 375 |
| Total value at wells of all oil produced, excluding pipage | $10, 881 |
| Value per barrel | 0. 32⅝ |

The stock on hand at the wells December 31, 1889, was 12,250 barrels of fuel oil.

### WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1889 | 3 |
| Total number of flowing wells December 31, 1889 | 3 |
| Number of wells completed in 1889 | 3 |
| Number of producing wells completed in 1889 | 3 |
| Initial daily production of new wells (barrels) | 1, 135 |
| Number of rigs building December 31, 1888 | 1 |
| Value of materials used in pumping, caring for, and operating wells in 1889 | $15, 777 |

### CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | a$49, 918 |
| Number of acres of oil land leased | 12, 585 | |
| Present value of land | | 5, 528 |
| Average value per acre, $0.44. | | |
| Value of rigs, wells, engines, boilers, etc | | $15, 650 |
| Value of tanks | | 10, 335 |
| Value of tank cars | | 5, 800 |
| Value of pipe lines at wells owned by parties making report | | 2, 130 |
| Value of oil in stock at wells December 31, 1889 | | 4, 075 |
| Value of other property and improvements | | 6, 400 |
| Total | | 44, 390 |

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[a] In addition to the above, information has been received of the expenditure of $54,874 in the drilling of 17 wells in Vigo county, all of which were dry holes. Of this amount $51,524 is reported as absolutely lost.

### LABOR AND WAGES.

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of foremen or overseers | 1 | |
| Total wages paid all workmen of this class in 1889 | | $1,200 |
| Number of mechanics | 7 | |
| Total wages paid all workmen of this class in 1889 | | 725 |
| Number of laborers | 25 | |
| Total wages paid all workmen of this class in 1889 | | 4,105 |
| Office force: | | |
| Total number (males) | 1 | |
| Total wages paid (males) | | 50 |
| Total number of persons employed and wages paid in 1889 | 34 | 6,080 |

| | |
|---|---|
| Wages paid for labor: | |
| In building rigs | $125 |
| In drilling wells | 600 |
| In operating and caring for wells | 5,305 |
| In office | 50 |
| Total | 6,080 |

### CLASSIFIED WAGES.

| CLASS OF LABOR. | Number of each class. | Range of wages. | Days employed. |
|---|---|---|---|
| Foremen | 1 | $150 per month | 240 |
| Rig builders | 8 | $125 per rig | |
| Drillers | 4 | 60 cents per foot | |
| Laborers | 1 | $25 per month | |
| Sundry mechanics | 22 | $75 per month | |

## KENTUCKY.

The only petroleum produced in Kentucky in 1889 was from the Boyds Creek district, in Barren county, some 3.5 miles from Glasgow. From January to August, 5 wells were operated in this district, and 6 from August to the close of the year. Some 5,400 barrels were produced, which were distilled (it could hardly be called refined) by the operator in a still near the wells, and the distillates sent to Louisville to be refined. The naphtha and residuum were also shipped to the Louisville refinery.

Near Somerset, Pulaski county, oil was struck about 85 feet below the surface. The oil sand was drilled into to a depth of 45 feet, and it was in this rock that the oil was procured. Just before boring this well the same operators bored another one at a point 4 or 5 miles northeast, in which the same oil-bearing rock was struck near the surface; there was, however, barely a showing of oil. The results obtained in drilling these wells convinced the operators that the dip of the oil-bearing sand rock was in a southwesterly direction, and their opinion is substantiated by the fact that many years ago some wells were developed at a point 40 miles southwest of the second well referred to. The well first referred to was plugged after some 3 or 4 barrels of oil had been obtained, the operators concluding that to obtain oil in paying quantities they would have to go farther southwest.

This oil has been tested by Professor W. Dicore, of Cincinnati, Ohio. It shows a specific gravity of 0.870, of 43½° B., and on distillation 5 per cent of light oil boiling below 130° F., 18 per cent of light oil boiling at from 130° to 300° F., and 34 per cent of illuminant of 48° gravity B.

After these are taken off a lubricating oil of 28° B. is obtained, which, on further heating, yields oil of 39° B., out of which 17 per cent of heavy lamp oil of 43° can be produced, increasing the total of lamp oil to 51 per cent. The remainder is a lubricating oil (of a consistency like linseed oil) of 22° B., flashing at 330° F.

The color of the crude oil is a greenish brown, and the odor not more offensive than that of well purified gasoline. There is no sediment or inorganic substance, nor a separation of the higher hydrocarbons after long standing.

In Russell county some 15 or 16 years ago (1874) a refinery was operated by some parties who also had a well at the same location, but during their operations there was a great depression in the price of oil, and, coupled with the burning of their tank and the fact that they had no means of transporting their product, except in wagons for a long distance in order to reach railway transportation, they could not make the continued operation of their well profitable. It was therefore abandoned and the well plugged. The oil is still there and can be seen seeping from the hole, and is of the same character as the oil found near Somerset.

About the same time that this refinery and well were operated in Russell county there were some wells bored in Cumberland county, which adjoins Russell county, but they were also abandoned about the same time that the

Russell county operators ceased, and for similar reasons, namely, lack of transportation facilities and depression in the price of oil.

Early in 1890 there was 1 well being drilled in Cumberland county and 3 rigs in course of construction for the purpose of further development, and it was said that there would be 10 or 12 rigs at work in this and Russell counties during the earlier months of that year.

Natural gas in considerable volume was struck early in January, 1890, in Cumberland county, but was cased off, since the operators wished to continue drilling for the purpose of finding oil, for which there was every prospect of success.

Wayne county also had producing oil wells in former years, which likewise were abandoned for the lack of transportation and the failure of the company prosecuting the development.

In all there are upward of 70,000 acres of land under lease for oil purposes in Pulaski, Wayne, Russell, Clinton, and Cumberland counties, to which that under lease in Barren county should be added.

Operations are being energetically pushed in Barren county, which lies west of Russell and Cumberland counties, and a refinery was being erected near Glasgow late in 1889. Wells completed in this county, however, were not found to exceed 15 barrels daily production.

A little heavy, dark oil, with weak brine, has been found at a depth of 70 feet near Lexington, in the Trenton rock. Near North Middletown, Bourbon county, a well in the Lower Hudson 98 feet deep yielded in 1888 100 gallons of good lubricating oil per week. The oil is black, and has a gravity of 23.5° B.

The statistics of the production of petroleum in Kentucky in 1889 are as follows:

TOTAL PRODUCTION AND VALUE.

| | |
|---|---|
| Total production in 1889 (barrels of 42 gallons) | 5,400 |
| Total value at wells of all oil produced, excluding pipage | $5,400 |
| Value per barrel | $1 |

No stock is reported on hand December 31, 1888 and 1889.

WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 5 |
| Total number of producing wells December 31, 1889 | 6 |
| Number of pumping wells December 31, 1888 | 5 |
| Number of pumping wells December 31, 1889 | 6 |
| Number of wells completed in 1889 | 3 |
| Number of dry holes in 1889 | 1 |
| Number of producing wells completed in 1889 | 2 |
| Initial daily production of new wells (barrels) | 7 |
| Value of materials used in caring for and operating wells in 1889 | $3,050 |

CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $25,000 |
| Number of acres of oil land: | | |
| Owned | 100 | |
| Leased | 51,500 | |
| Total acreage | 51,600 | |
| Present value of land, both owned and leased (actual expenditures on same for oil purposes) | | 10,150 |
| Average value per acre, $0.20. | | |
| Value of rigs, wells, engines, boilers, etc | | $9,000 |
| Value of tanks | | 750 |
| Value of tank cars | | 1,800 |
| Value of pipe lines at wells owned by parties making report | | 200 |
| Value of other property and improvements | | 3,100 |
| Total | | 14,850 |

### LABOR AND WAGES.

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of foremen or overseers | 2 | |
| Total wages paid all workmen of this class in 1889 | .... | $1,248 |
| Number of mechanics | 8 | |
| Total wages paid all workmen of this class in 1889 | .... | 660 |
| Number of laborers | 4 | |
| Total wages paid all workmen of this class in 1889 | .... | 1,142 |
| Total number of persons employed and wages paid in 1889 | 14 | 3,050 |
| Wages paid for labor: | | |
| In building rigs | | $200 |
| In drilling wells (part contract) | | 1,650 |
| In operating and caring for wells | | 1,200 |
| Total | | 3,050 |

### CLASSIFIED WAGES.

| CLASS OF LABOR. | Number of each class. | Range of wages. | Days employed. |
|---|---|---|---|
| Foremen | 2 | $52.50 to $70 per month | 50 to 313 |
| Pumpers or engineers | 4 | $24 to $30 per month | 50 to 313 |
| Rig builders | 2 | $1 per day | 20 |
| Drillers | 4 | 60 cents per foot | 40 |
| Tool dressers | 2 | $1.75 per day | 40 |
| Laborers | 2 | 90 cents to $1 per day | Various. |

## ILLINOIS.

The only oil produced in Illinois in 1889 was from some wells near Litchfield, in Montgomery county. The oil is a lubricating one, dark, almost black in color, and of 22° B. specific gravity. The cold test is remarkable, the oil remaining fluid at 20° below zero. It is largely used by the factories in the neighborhood of Litchfield, and is sold to consumers at near-by points for lubricating purposes, bringing from 8 to 10 cents per gallon in bulk, according to quantity.

In all there have been 30 wells bored in the neighborhood of Litchfield, chiefly for gas. The depth of these wells ranges from 640 to 670 feet. All save 5 were abandoned years ago. These 5 wells continue to produce the character of petroleum mentioned above. The average production of these wells is about 4 barrels a day. They are pumped by heads, and 1 man attends to them all. Natural gas from wells near by is used to some extent in furnishing fuel for pumping the wells. The supply of gas is about equal to 12 tons of coal a year, and 12 tons additional are used in pumping. The supply of natural gas is gradually diminishing.

The statistics of the production of petroleum in Illinois in 1889 are as follows:

### TOTAL PRODUCTION AND VALUE.

| | |
|---|---|
| Total production in 1889 (barrels of 42 gallons) | 1,460 |
| Total value at wells of all oil produced, excluding pipage | $4,906 |
| Value per barrel | $3.36 |

### STOCKS OF OIL ON HAND AT WELLS.

| | BARRELS. |
|---|---|
| December 31, 1888 | 110 |
| December 31, 1889 | 100 |

### WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 5 |
| Total number of producing wells December 31, 1889 | 5 |
| Total number of pumping wells December 31, 1888 | 5 |
| Total number of pumping wells December 31, 1889 | 5 |
| Value of materials used in pumping, operating, and caring for wells in 1889 | $760 |

### CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $12,336 |
| Number of acres of oil land: | | |
| Owned | 20 | |
| Leased | 5,000 | |
| Total acreage | 5,020 | |
| Present value of land, both owned and leased | | 2,600 |
| Average value per acre, $0.52. | | |
| Value of rigs, wells, engines, boilers, etc | | $9,000 |
| Value of tanks | | 250 |
| Value of pipe lines at wells owned by parties making report | | 150 |
| Value of oil in stock at wells December 31, 1889 | | 336 |
| Total | | 9,736 |

### LABOR AND WAGES.

| | |
|---|---|
| Total number of persons employed in 1889 | 1 |
| Total wages paid all workmen | [a]$600 |

[a] Paid for operating and caring for wells.

1 engineer or pumper was employed 365 days at $50 per month.

## KANSAS.

The only section of Kansas in which oil has been found in what may be termed paying quantities, and even here the production is very small, is in Miami county, near Paola. In this county "tar" or oil springs have been known to exist from the earliest settlement of the state. One of these springs, some 8 miles east of the town of Paola, has led to the drilling of a number of wells in search of oil during the past 30 years. As early as 1858 leases were obtained, and there was considerable talk of developing the oil field here. In 1861 a well was drilled 5 miles east of Paola, in which it is reported that oil was found, but the well filled with water, soon caved in, and no oil in commercial quantities was produced. Another well was started 2 miles east of Paola in the same year, but was abandoned before the oil rock was reached.

In a report made by Professor Mudge in 1864 he refers to the existence of oil and bitumen in the eastern tiers of counties of the state. In Professor Swallow's report of 1865 he makes reference to 19 different tar springs within Miami county, and adds that "scarcely a well has been dug without finding petroleum in some of its forms". Professor Swallow concludes that these facts are "very strong evidence of the existence of large reservoirs in these localities". Although large reservoirs of oil or gas may be found, as Professor Swallow predicted, yet the facts which he presents in themselves are not necessarily sufficient to warrant such a conclusion.

In 1865 a Saint Louis company drilled 2 wells about 10 miles east of Paola. These wells were reported to have been drilled to a depth of 700 feet, when the tools were lost.

In 1873 a company was organized, known as the Kansas Mining Company, and the same year drilled a well on the northeast quarter of section 16, township 19, range 24 (Westfall farm), near one of the largest of the "tar springs". At a depth of 320 feet a strong flow of gas was found and work stopped. Other gas wells were soon drilled on the same farm and gas was piped to Paola, a distance of 7 miles, by the Paola Gas Company.

In 1888 one of the wells on the Westfall farm was drilled deeper, and it was found that under the gas rock there was an oil rock 12 to 16 feet thick, producing a very heavy black oil. This well bailed from 1 to 2 barrels per day. As the oil interfered with the gas, for which the well was drilled, it was plugged off at the bottom of the gas rock and the well turned again into the gas main. It was soon ascertained, however, that the oil was of such value as a lubricant that wells of 1 or 2 barrels per day could be worked at a profit, and the Paola Gas and Land Company purchased the property of the Paola Gas Company, and prospecting for oil began in the spring of 1889. The first well of recent years, drilled especially for oil, was put down in May, 1889, on the northwest quarter of section 16, township 17, range 24, and at a depth of 330 feet a good oil sand was struck, the gas sand lying at 316 and 328 feet and the oil sand at 330 to 341 feet. This well, known as No. 29, was shot with 10 quarts of nitroglycerin, and when cleaned out the gas shot a stream of oil to the top of the derrick. The well was tubed, the casing head packed, and the oil flowed by the gas. This well at first produced 15 barrels per day for 4 months.

In the fall of 1889 and spring of 1890 4 wells were drilled by the same company 3 miles southwest of Paola, and the oil rock struck at about the same level as in the eastern field, but the rock was much harder and the oil much lighter. The west field has a much stronger head and promises a much larger yield than the east field.

There are at least 3 districts near Paola. The first is Russell tract, or Westfall farm, about 7 miles east of Paola and 2 miles from Somerset station, on the Missouri Pacific railroad; the others are nearer Paola, one being 3 miles southwest, as above noted, and the other just at the edge of the town.

As above noted, gas was at first the object of the recent drilling near Paola. Well No. 1 in Russell tract was bored for gas in 1882. Since that time 56 wells have been drilled by the Paola Oil, Gas and Mining Company and its predecessors. As stated above, it was not until 1888 that wells began to be drilled for oil. The Russell tract is now one of value as an oil producer, the pressure of the gas not being strong enough to force it through the 2½ inch pipe laid from Russell to Paola, a distance of 7 miles. 13 wells are now (1890) producing oil.

The structural geological conditions of Kansas when viewed by themselves are favorable to the existence of natural gas and oil. The rocks underlying Kansas are comparatively horizontal, the general dip being toward the west and northwest. The highest geological strata in eastern Kansas is the carboniferous, while westwardly higher formations are found. Going from the northern toward the southern portion of the state, within the coal measure area, the strata thicken, as the records of the oil and salt wells in Miami county seem to prove.

The best oil well in this district, No. 39, drilled in May, 1889, has the following record:

| | FEET. |
|---|---|
| Cased to | 280 |
| Soapstone | 20 |
| Sandy shale | 11 |
| White slate | 3 |
| Gas sand (very good) | 10 |
| White slate | 4 |
| Oil sand | 13 |
| Total | 341 |

The sand in which the oil is found is stated to be "identical with Bradford in appearance". It certainly has that look of light-colored coarse maple sugar that is seen in the Bradford sand when filled with oil.

The oil itself is a heavy, black, fatty substance of remarkable lubricating properties. A test taken by the writer on the afternoon of May 7, 1891, temperature 70° F., showed the gravity to be 23½° B., zero cold test, and 280° fire test. This refers to the oil in the Russell tract, or from the Westfall farm. That from the district 3 miles southwest of Paola is much lighter, having a gravity of 30°, zero cold test, 100° fire test, and not so densely black as the oil in the eastern field. The oil contains none of the lighter hydrocarbons; even at 300° F. nothing distilled over. A little water remains obstinately entangled in the oil, which at that temperature produces frothing to such a degree as to interrupt further distillation. Even in some cases the temperature of the retort has been carried to 400° F. without the production of a drop of distillate. As stated above, the quality of this oil as a lubricant is phenomenal. Without the least artificial preparation it has given some remarkable results as a lubricant under the most severe tests, especially on railroads running through the alkali country.

While the foregoing statements apply chiefly to the oil produced in Miami county near Paola, oil has been found in other portions of the state apparently on the same general degree line as at Paola. These discoveries of oil have been made chiefly when boring for natural gas.

In Kansas City, Kansas, oil was struck when boring for natural gas, usually at a depth of from 300 to 400 feet. As natural gas was the product sought in drilling the wells, and as it was difficult to market the oil, which was produced in small quantities, at satisfactory prices, the wells were allowed to drown out in most cases when it was found that they did not produce sufficient natural gas to pay for operating them.

The record of a well bored in Kansas City is as follows:

RECORD OF A WELL BORED AT KANSAS CITY, KANSAS, FOR NATURAL GAS IN 1889.

[Feet.]

| STRATA. | Thickness of each stratum. | Total depth. |
|---|---|---|
| Loam and clay | 14.0 | 14.0 |
| Limestone | 19.0 | 33.0 |
| Shale | 30.0 | 63.0 |
| Limestone | 12.0 | 75.0 |
| Shale | 5.0 | 80.0 |
| Limestone | 20.0 | 100.0 |
| Shale | 5.0 | 105.0 |
| Limestone | 10.0 | 115.0 |
| Shale | 30.0 | 145.0 |
| Flint | 10.0 | 155.0 |
| Shale | 25.0 | 180.0 |
| Limestone | 15.0 | 195.0 |
| Shale | 18.0 | 213.0 |
| Limestone | 10.0 | 223.0 |
| Shale | 170.0 | 393.0 |
| Limestone | 5.0 | 398.0 |
| Shale | 38.0 | 436.0 |
| Limestone | 4.0 | 440.0 |
| Black shale | 26.0 | 466.0 |
| Sand rock | 16.8 | 482.8 |

Oil was struck at a little over 400 feet; gas from 266 to 476 feet; hard, close sand from 476 to 480 feet; gas from 480 to 482.8 feet.

At Fort Scott, Kansas, oil was found in 2 or 3 wells when drilling for natural gas. Its character seemed to be the same as that of the Paola oil. As the quantity of gas was insufficient to pay for operating the wells they were abandoned. At Wyandotte and Coffeyville oil has been found under similar conditions to those existing at Paola, but no attempt has been made to save the same.

It has been extremely difficult to secure statistics of the production of oil in Kansas for 1889, as no record was kept. The best information received indicates that there were 3 wells producing oil December 31, 1889, at Paola, the production for that year being about 300 barrels, valued at $1,500. Nearly the entire amount of this oil remained on hand at the close of the year, little or no product having been sold.

A small amount of oil, some 200 barrels, was also produced in Kansas City from wells drilled for gas. This was also lubricating oil of about the same quality as that produced in Paola.

The statistics of the production of petroleum in Kansas in 1889 are as follows:

### TOTAL PRODUCTION AND VALUE.

| | |
|---|---|
| Total production in 1889 (barrels of 42 gallons) | 500 |
| Total value at wells of all oil produced, excluding pipage | $2,500 |
| Value per barrel | $5 |

### STOCKS OF OIL ON HAND AT WELLS.

| | BARRELS. |
|---|---|
| December 31, 1888 | 100 |
| December 31, 1889 | 100 |

### WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 4 |
| Total number of producing wells December 31, 1889 | 4 |
| Total number of pumping wells December 31, 1888 | 4 |
| Total number of pumping wells December 31, 1889 | 4 |
| Number of rigs building December 31, 1889 | 2 |
| Value of material used in pumping, caring for, and operating wells in 1889 | $500 |

### CAPITAL.

| | | |
|---|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | | $75,000 |
| Number of acres of oil land leased | 4,000 | |
| Present value of land | | 40,000 |
| Average value per acre, $10. | | |
| Value of rigs, wells, engines, boilers, etc. | | $25,000 |
| Value of tanks | | 2,500 |
| Value of pipe lines at wells owned by parties making report | | 3,000 |
| Value of oil in stock at wells December 31, 1889 | | 500 |
| Value of other property and improvements | | 4,000 |
| Total | | 35,000 |

### LABOR AND WAGES.

| | | |
|---|---|---|
| All labor, not including office force: | | |
| Number of mechanics | 2 | |
| Total wages paid all workmen of this class in 1889 | | $1,000 |
| Number of laborers | 6 | |
| Total wages paid all workmen of this class in 1889 | | 2,500 |
| Office force: | | |
| Total number (males) | 2 | |
| Total wages paid (males) | | 2,500 |
| Total number of persons employed and wages paid in 1889 | 10 | 6,000 |
| Wages paid for labor: | | |
| In building rigs | | $300 |
| In operating and caring for wells | | 3,000 |
| In building or repairing tankage | | 100 |
| In building and repairing pipe lines | | 100 |
| In office | | 2,500 |
| Total | | 6,000 |

### CLASSIFIED WAGES.

| CLASS OF LABOR. | Number of each class. | Range of wages. | Days employed. |
|---|---|---|---|
| Pumpers or engineers | 1 | $1.50 per day | All. |
| Carpenters | 1 | $2.50 per day | 200 |
| Rig builders | 1 | $2.50 per day | 100 |
| Drillers | 2 | $3.50 per day | 250 |
| Tool dressers | 2 | $2 per day | 250 |
| Laborers | 2 | $1.25 per day | 300 |

## TEXAS.

Similar conditions to those found in Kansas, New Mexico, and the southern part of California exist in Texas. Springs known locally as tar springs are found scattered over various portions of the state, especially in the northeast, southeast, and central portions. The oil wells of Kansas and Missouri are found a little east of the ninety-fifth meridian of longitude west of Greenwich. The Texas springs are a little to the east of the ninety-fourth meridian, and some are also found on the ninety-third and east of it. The petroleum produced in Texas in 1889 was in Bexar county, near San Antonio, about midway between the ninety-eighth and ninety-ninth meridians.

The product of these springs is known locally as petroleum, and is in this report so classified, though some geologists, especially those who have been connected with the geological survey of California, insist on calling it maltha. At present, however, they acknowledge that this so-called maltha and petroleum are similar substances. Chemically they may be; practically they are not.

The Texas oil is a natural lubricator of from 28° to 30° gravity, and is said to be found in a conglomerate. The wells are shallow, the oil being struck in various parts of the state at from 125 to 350 feet. The Bexar county wells, which produced the petroleum reported upon from this state in 1889, are about 300 feet deep. As there is but a limited demand for the oil, there is no effort to produce it in large quantities. The 2 wells producing in 1889, which were on the ranch of Mr. George Dulnig, were wells that had been drilled originally for procuring water. They were found to yield small quantities of oil and gas. The production of these 2 wells in 1889 was about 4 barrels a month.

Outside of the oil produced in Bexar county none seems to have been produced in the state on a commercial scale, though reports as to the discovery of oil at various points in Texas are frequent. At Sulphur Springs, in Hopkins county, there are certain so-called "sour wells", which produced a few gallons of oil. In 1887 and 1888 considerable excitement was occasioned by the reported striking of oil in Nacogdoches county. The locality was some 80 miles southwest of Shreveport. The wells were driven wells, and some oil was obtained at the depth of 85 feet, in other cases at a depth of 300 feet. Quite a number of wells were driven in 1887 and 1888, but no petroleum was produced in 1889.

The oil produced in Bexar county was used for lubrication. It retailed in barrels at 20 cents a gallon, in tin cans of 5 gallons at 30 cents, and in smaller quantities than 5 gallons at 35 cents a gallon.

The statistics of the production of petroleum in Texas in 1889 are as follows:

### TOTAL PRODUCTION AND VALUE.

| | |
|---|---|
| Total production (barrels of 42 gallons) | 48 |
| Total value at wells of all oil produced, excluding pipage | $340 |
| Value per barrel | $7.08⅓ |

### STOCKS OF OIL ON HAND AT WELLS.

| | BARRELS. |
|---|---|
| December 31, 1888 | 6 |
| December 31, 1889 | 48 |

### WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 2 |
| Total number of producing wells December 31, 1889 | 2 |
| Total number of pumping wells December 31, 1888 | 2 |
| Total number of pumping wells December 31, 1889 | 2 |

### CAPITAL.

| | |
|---|---|
| Total capital invested in wells (*a*), leases, etc., and employed in the business | $1,650 |
| Value of rigs, wells, engines, boilers, etc | 1,200 |
| Value of tanks | 100 |
| Value of pipe lines at wells owned by party making report | 10 |
| Value of oil in stock at wells December 31, 1889 | 340 |
| Total | 1,650 |

*a* These wells are sunk on the ranch of the owner, and no value is placed upon the land as oil territory.

The work is all done by ranch hands; no special men are employed, the production of the wells being but 4 barrels per month.

## MISSOURI.

The only oil produced in Missouri in 1889 concerning which it has been possible to secure any information was in west Boone township, Bates county, near the Kansas state line, southwest from Paola, where the oil produced in Kansas in 1889 was found.

This oil was all produced from 1 well drilled in 1886 for water. The oil comes from sand 220 feet in depth. It is similar in every respect to the Kansas oil. The well is pumped by a windmill and yields less than 1 barrel a day. The oil is sold to local trade for lubricating purposes. In 1889, 20 barrels of oil, valued at $40, were produced. All oil is sold as soon as produced.

The cost of operating the well in 1889 was $350; the total capital, $750. The territory consists of 600 acres of land, valued, as oil territory, at $210, the rigs, wells, engines, etc., being valued at $520 and tank at $20. There was but 1 producing well and 1 tank. The cost of drilling the well was $1.50 a foot.

There is an interesting history connected with the drilling of some wells at Adrian, Bates county, Missouri. Oil was discovered here in 1889 at a depth of 33 feet while prospecting for coal. The oil sand was some 25 feet thick, overlaid with soapstone shale to a thickness of 8 feet. The oil oozed from the rock into the shaft and was bailed out. The shaft was in the creek bottom, and being flooded by the first high water the well ceased to produce.

A number of drill holes were then put down. 3 of these produced about 6 gallons in 10 hours, but the holes were not cased, and they were soon drained out by water.

In 1883 a derrick was erected, proper oil tools procured, and a well sunk over 500 feet. All the oil secured in this well was found at from 33 to 90 feet in depth. The well was pumped but once, and then only for 10 hours, the product being 20 gallons of oil, with a large quantity of water.

The oil is similar in character to that found at Paola.

Mr. R. B. Marshall, of Adrian, states that he has done a great deal of prospecting for oil in that section of the country, and finds a strip of territory some 10 miles long and from 1 to 3 miles wide underlaid with gas and oil, but that the difficulty with the region as a producing territory is that the sand is too fine and the oil too thick to give any great production. There is a great deal of sand rock impregnated with oil which can be driven out by heat.

The statistics of the production of petroleum in Missouri in 1889 are as follows:

### TOTAL PRODUCTION AND VALUE.

| | |
|---|---|
| Total production in 1889 (barrels of 42 gallons) | 20 |
| Total value at wells of all oil produced, excluding pipage | $40 |
| Value per barrel | $2 |

No stock was reported on hand at the wells December 31, 1888 and 1889.

### WELL RECORD.

| | |
|---|---|
| Total number of producing wells December 31, 1888 | 1 |
| Total number of producing wells December 31, 1889 | 1 |
| Total number of pumping wells December 31, 1888 | 1 |
| Total number of pumping wells December 31, 1889 | 1 |
| Value of materials used in pumping, operating, and caring for wells in 1889 | $5 |

### CAPITAL.

| | |
|---|---|
| Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business | $750 |
| Number of acres of oil land owned | 600 |
| Present value of land as oil territory | $210 |
| Average value per acre, $0.35. | |
| Value of rigs, wells, engines, boilers, etc | $520 |
| Value of tanks | 20 |
| Total | 540 |

### LABOR AND WAGES.

| | |
|---|---|
| Total number of persons employed in 1889 | 1 |
| Total wages paid all workmen | *a*$350 |

*a* Paid for operating and caring for wells.

## TENNESSEE.

At a point about 8 miles north of White Bluff, in Dickson county, Tennessee, on Jones creek, oil has been known to exist since 1865. It is said 7 wells have been drilled at this place by different parties, some of them being shallow, and the deepest well being upward of 2,000 feet deep. There was but 1 actually dry hole, and that was abandoned at 640 feet. The shallow wells produced oil in small quantities at a depth of 187 feet. 2 wells have been cased and have small quantities of oil in them, but since there is no market for crude oil in this state or immediate vicinity wells have been neglected and no attention paid to its development. The product is not utilized except to a small extent for lubricating purposes. It is firmly maintained by residents there that oil can be found in remunerative quantities.

Oil is generally found at an average depth of 150 feet, in a sandstone of 20 feet thickness. Gas and salt water are also found.

## ALABAMA.

Though no oil was produced in Alabama during the census year, still, in view of the fact that drilling was recommenced in 1890, some account is given of the history of oil production in this state and the prospects of future production.

In various parts of northern Alabama there are found springs which yield natural gas and petroleum to a limited extent, though as yet these products have not been found in sufficient quantities to be of any commercial value. There are also found in the same section in the outcroppings of the carboniferous formations "tar" springs somewhat similar to those of California, from which there exudes a thin bitumen, known as "maltha". Shortly after the beginning of the petroleum excitement in Pennsylvania in 1859 many wells were drilled at points indicated by these natural gas and petroleum and tar springs. Some oil was found, but not in sufficient quantities to justify the continuance of operations.

The best known of the Alabama tar springs are just outside of Moulton valley. These springs are in the outcroppings of a very highly fossiliferous, coarse-grained, siliceous limestone that has a cover of reddish and greenish argillaceous shales. Near the lower of the 2 springs is a well said to have been drilled for oil some years ago to a depth of 106 to 107 feet. The Goyer Oil Company, of Memphis, Tennessee, proposes to put down wells near these springs. At present (June, 1891) 2 wells have been completed, in 1 of which a dark-green oil was found at a depth of 1,509 feet. The first oil secured in small quantities was at the top of the Trenton limestone, at a depth of 1,355 feet. This well was computed by Dr. McRae to be a 25-barrel well. The second oil sand, from which most of the oil came, is believed by Mr. Henry McCalley to be some 300 feet down in the Trenton limestone, or some 200 feet lower geologically than any known productive oil sand in this country.

Oil wells are to be drilled in other parts of the state.

## WYOMING.

Though oil has been known to exist in Wyoming for more than 30 years, and though developments made in 1885 and since point to the presence of valuable oil deposits in this territory, the oil industry has assumed, as yet, no importance, owing chiefly to the distance of the producing territory from any important market and the expense of transportation thereto.

The developments of importance have been confined chiefly to 2 districts, one known as the "George B. Graff oil-mining district", in the county of Fremont, in the western part of the territory, not far from Dallas, and at the base of the Wind River mountain, and the other known as the "Stockade oil-mining district", in Weston county, in the extreme northeastern part of the territory, near the Black hills and New Castle.

The first district, the "George B. Graff", is named for the late Dr. George B. Graff, of Omaha, who developed the property. The amount of oil in this district is indicated from the fact that there are about 50 open oil springs in Fremont county, 14 within a radius of 20 miles of Lander.

In 1885, 4 wells were sunk to the upper oil-bearing sand. The depth of these wells and their product, as given at that time, are as follows:

| WELLS. | Depth, in feet. | Flow per day. in barrels. |
|---|---|---|
| Total |  | 1,335 |
| No. 1 | 85 | 85 |
| No. 2 | 100 | 100 |
| No. 3 | 350 | 325 |
| No. 4 | 1,200 | 825 |

It is probable the production of some of these wells as given is too great. Several statements received from this district are to the effect that 3 of the wells which were drilled about this time were shut in or "packed" with Hodley packers; that they would produce, if they were allowed to flow, or, to use the local expression, "let loose", some 200 barrels per day per well, and that in the neighborhood of these wells a lake, 300 yards long by 30 yards wide, was made to receive their overflow, and it is estimated that in this lake there are now some 15,000 barrels that were produced as long ago as 1886. Nothing has been done in the way of development or production in this district since this date.

Regarding this oil field, Mr. L. D. Ricketts, territorial geologist, states: "These wells are cased and supplied with valves to prevent the oil from escaping, but owing to the great gas pressure a leakage can not be prevented. The pressure is so great that upon suddenly opening the valves the oil spurts up 75 feet into the air, like some black-watered geyser. After the pipe thus clears itself the steady flow of oil is resumed, which, as variously estimated, will aggregate from 600 to 1,000 barrels per 24 hours."

The oil is found in 2 strata, the upper a "black sand", averaging about 70 feet in thickness, and the other is a "black pebble" or "dark conglomerate", varying in thickness, according to different authorities, from 400 to 800 feet. The oil in this district is low in illuminants, averaging about 25 per cent. It is proposed, and a company has been organized for the purpose, to pipe the oil to Denver, 250 miles distant, and to sell it for fuel.

Regarding the second district, the "Stockade oil-mining district", which is located in the Black hills near New Castle, in Weston county, but little information has been obtained. A large quantity of government land, supposed to contain oil, has been located in this district. A list of some 376 locations of 160 acres each, amounting to 60,160 acres, has been furnished the special agent. This land, at the government price of $2.50 an acre, would be valued at $150,400. In order to hold these leases $200 worth of improvements must be put upon the land. If all of the claims were finally taken up, this would add $75,200 to the value of the land entered as oil land in this district. It is known, however, that in many cases the claims have been abandoned. So far as has been learned, no amount of oil has ever been produced in this district, though indications are very favorable to the securing of a large supply.

## NEW MEXICO.

Information has been received of a very small production of a heavy lubricating oil in Bernalillo county, on section 11, township 16 north, range 16 west. This oil flows naturally from the rocks containing it. The product is stated to be a barrel a day, which is probably in excess of the actual production. It is sold in small quantities to consumers in the immediate vicinity at the rate of $10 a barrel. The larger proportion of the production is wasted and lost.

It is also reported that there are several places on the Navajo Indian reservation where petroleum exudes in a similar manner from the crevices in bituminous sandstone, and there is no doubt that at many places in New Mexico the same phenomena that are noticed in Colorado and Wyoming will be found to exist.

# NATURAL GAS.

# NATURAL GAS.

BY JOSEPH D. WEEKS.

Many difficult but important questions have arisen in connection with this investigation, and in some cases they have been unusual, if not unique. For the solution of some of these there was no help to be obtained from previous censuses, as the production of natural gas was not an industry prior to the period embraced in the Eleventh Census. Some of the questions referred to have arisen in connection with the collection of the statistics of natural gas for the volume Mineral Resources of the United States, issued by the United States geological survey, and have been decided, but others are entirely new.

Since there is such an intimate connection between the geological horizons in which gas and oil are found, and the localities in which they occur are so nearly identical, the reader is referred to the report on petroleum, page 425 of this volume, to avoid verbatim reproduction of the discussions of these subjects.

In Pennsylvania and New York, and to some extent in other states, much of the gas produced is not used at the place of production, but is transported in pipes to other towns, and even to other counties and states, where it is consumed. The gas used in Pittsburg, which is in Allegheny county, Pennsylvania, comes chiefly from Westmoreland and Washington counties; that used at Johnstown, Cambria county, from Westmoreland county. The United Natural Gas Company, with its home office in Oil City, Venango county, Pennsylvania, has wells in McKean, Potter, and Butler counties, Pennsylvania, and in Allegany county, New York, from which gas is drawn not only to supply towns in these counties, but to pipe to other counties in Pennsylvania, and even to places in New York as far away as Buffalo, and to Youngstown, Ohio. Wheeling, West Virginia, gets its supply of gas from Washington county, Pennsylvania.

The question at once arose, to what county shall the statistics of this gas be credited? If only the question of production had been involved the answer would have been simple: to the place of production, of course. But, unlike other investigations, this included not only production but consumption as well. Indeed, its statistics of production are really those of consumption. Its measure of production is the amount consumed. No value can be placed upon the gas except as it is consumed. The gas wasted at the wells has no value. It is not stored, in the proper sense of the term, as it is produced, and it is not until it is burned in the grates or in the furnaces that it has commercial value. Hence its value at the point of consumption, and not of production, is the one that must be considered. In arriving at this value by the method of fuel displacement, which is one, and the most important, of the methods adopted, it was the value of the coal or wood displaced at the point of consumption, not of production, that was taken. Now, the question was, should this value be regarded as a value of an industry where the gas was produced or where it was used? The difficulty of arriving at a satisfactory conclusion was increased by other difficulties and questions which will be noted below, but the conclusion reached was that, in view of all circumstances, the production, value, etc., should be credited to the place of production, even though to ascertain this production and value we must go to the point of consumption.

This did not remove the difficulty, however. In many cases it is impossible to state the particular county from which comes the gas burned at a given place. In the neighborhood of Pittsburg this problem is not a difficult one. Practically all the gas produced by the Philadelphia Company, which supplies most of the gas used in Pittsburg, is from Westmoreland county, and the place of production of the gas furnished consumers by the other companies is easily ascertained; but in the case of the United Natural Gas Company of Northwestern Pennsylvania, that drew its supplies from 4 counties and sent gas to Buffalo from the wells of at least 3 counties through the same pipe line, the difficulty of determining how much gas came from each county added a new problem. This company was able, however, to give an approximately correct statement as to the amount of gas produced in each county. The company's total production was estimated at 7,312,000,000 cubic feet, produced as follows:

DISTRIBUTION, BY COUNTIES, OF THE GAS PRODUCT OF THE UNITED NATURAL GAS COMPANY.

| COUNTIES. | Number of wells. | Total production in 1889. (Cubic feet.) |
|---|---|---|
| Total | 97 | 7,312,000,000 |
| Allegany county, New York | 28 | 1,330,000,000 |
| McKean county, Pennsylvania | 45 | 5,030,000,000 |
| Potter county, Pennsylvania | 8 | 310,000,000 |
| Butler county, Pennsylvania | 16 | 642,000,000 |

In other cases of a similar character the owners of the wells have been able to give the percentage of the total product that should be placed to the credit of each county. Another complication has grown out of the fact that several companies distributing gas to consumers owned no wells and produced no gas, but bought gas from producers, who might themselves also sell to individual consumers. This required great care to avoid duplication. Another difficulty was to reach a unit of production. The proper unit of measurement is the cubic foot, but the conditions surrounding the production and consumption of natural gas are such as to make it absolutely impossible to reach accurate statements. The present report, therefore, only claims to be approximately correct, as it is impossible to ascertain the total production of natural gas in the United States in cubic feet, the only practical measurement for this product. A few wells have been accurately measured, but this measurement only gives the rate of production for the moment when the observations were taken, and this rate changes not only from day to day, but from hour to hour, and even from moment to moment. It is usually greater at certain times in the day, as in the morning, than at others. It also varies with the weather and state of the barometer. Consequently, even for the measured wells, only an approximate estimate of their production can be made, while for the unmeasured ones a fair statement is clearly impossible, though attempts have been made to procure data. These will be discussed elsewhere. Since the tendency is to exaggerate the production of natural gas, any figures as to production given may be safely considered as an overestimate, so far as the individual returns are concerned, though the totals for the United States are if anything an underestimate.

It is equally impossible to state, except approximately, the amount of gas consumed. Few meters to measure the gas were used in 1889, and only guesses as to the amount consumed can be given. Some discussion on this point will be given elsewhere.

It has been found exceedingly difficult not only to get accurate figures of production and consumption, but also accurate statements regarding the other details included in this report. This difficulty does not grow out of disinclination on the part of producers to give any information in their power, but comes from the peculiar character of the industry. A great many wells were bored in various sections of the United States in the hope of producing natural gas. Where these have been producers approximately correct records of cost, etc., are available. Where they have been small producers, or have been abandoned, or have been nonproducers, the facts regarding the cost, number of employés, etc., have been very difficult to procure. The wells in many cases have been drilled by nonresidents under contract or upon land that has been leased. When the venture has proved unsuccessful no record is preserved of cost, capital invested, wages paid, materials used, or any of the other details asked for in this report. For example, in looking at the table giving well records it will be seen that though wells were drilled in 1889 in Illinois, Texas, South Dakota, and Tennessee, there are blanks in the column of total cost, showing that no report as to cost could be secured from the parties drilling these wells. It will also be noted in West Virginia that 6 wells are reported as having been drilled, the total cost of which was but $2,000, which probably only includes the cost of a single small well. Concerning the other wells no figures could be secured; indeed, it is doubtful if any records were ever made.

Wherever it has been possible to do so estimates are made covering the missing figures, but it must be understood, unless it is expressly stated to the contrary, that the figures given in this report are only approximations, the best that could be made under the circumstances.

## LOCALITIES IN THE UNITED STATES WHERE NATURAL GAS IS FOUND.

In a general way it may be said that natural gas has been found in varying quantities all through the territory from the Hudson river on the east to California on the west. In Alabama, California, Colorado, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Missouri, New York, Ohio, Pennsylvania, South Dakota, Tennessee, Utah, West Virginia, Wisconsin, and Wyoming its existence is reported. In some of these states, however, it has not been found in commercial quantities. A shallow well, frequently a well put down for water, has shown the existence of gas, usually in the drift. In many cases also so-called gas springs have been found, from which a small supply of natural gas, usually marsh gas, is reported. In 1889 gas in commercial quantities was reported as having been produced in Arkansas, California, Illinois, Indiana, Kansas, Kentucky, Michigan, Missouri, New York, Ohio, Pennsylvania, South Dakota, Texas, and Utah. At the present time the important gas fields are those of western Pennsylvania, western New York, northwestern Ohio, and eastern central Indiana. It is the development of these districts that has caused the excitement in connection with natural gas which was so manifest in 1888 and to a less degree in 1889. The most important gas fields in these territories are those in the gas district in Pennsylvania in the neighborhood of Pittsburg, including the Murrysville and Grapeville fields, of Westmoreland county, and the several Washington county fields. In McKean and Venango counties there was also a large production of gas and considerable from Elk county. In Ohio the most important field is what has been called the Findlay, situated in Hancock county, while in Indiana the chief fields are in the neighborhood of Anderson, Kokomo, Marion, and Muncie. Each of these districts, as well as the other localities in which gas is found, will be discussed in connection with the report on the several states.

## HISTORY OF THE USE OF NATURAL GAS IN THE UNITED STATES.

The earliest economic use of natural gas in this country was probably in lighting the village of Fredonia, Chautauqua county, New York, in 1821. For many years prior to this, even as early as the date of the survey of the Holland Land Company, gas had been observed issuing from the crevices of the slate rocks along the banks of the Canadaway creek, on which Fredonia is built. In 1821 a well 1½ inches in diameter and 27 feet deep was put down near the Main street bridge, which crosses this creek. This was probably the first well sunk for the purpose of obtaining natural gas. This well produced gas sufficient for some 30 burners, the burner being made by drilling a hole the size of a small knitting needle in a pipe. The light from one of these burners was regarded as equal to that of "2 good candles". Gas of 2-candle power would hardly answer the demand of to-day. The gas was conveyed from the well to the buildings in which it was used in wooden pipes. In 1824, on the occasion of Lafayette's visit, the village was lighted with natural gas.

In 1825 a small gasometer was put in and the wooden pipes replaced with lead ones, which so improved the conditions that the Fredonia Censor of December, 1825, says: "We witnessed last evening the burning of 66 beautiful, clear gas lights, and 150 lights could be supplied from this gasometer. There is now sufficient gas to supply another one as large."

The existence and utilization of this gas at Fredonia became widely known, both in this country and abroad, and excited the liveliest interest among scientific men; but so little suspected was the presence of the enormous volume of gas since developed that it was pronounced "unparalleled on the face of the globe", and Humboldt is quoted as declaring it the eighth wonder of the world.

This well of 1821, which was afterward drilled to the depth of 70 feet into the black shales of the Marcellus beds, was the only one producing gas in the village until 1858, though another well was sunk in 1850. It yielded water as well as gas and required constant pumping, the gas not having pressure enough to force itself through the water. This well was in uninterrupted use until 1885, when some repairs to Tifft's mill, adjoining, made it necessary to tear away the pumping machinery. The product of gas was but a trifle less than when it was first completed.

In 1859 a well of a peculiar character was sunk, or, rather, the second well, that of 1850, was enlarged. A shaft 30 feet deep, 6 feet in diameter at the top and 14 feet at the bottom, was dug. From the bottom lateral and 2 vertical borings, one 100 feet deep, the other 150 feet, were put down. A production of 4,500 feet of gas a day was secured, supplying 200 burners. In 1871 a still larger well was bored to the depth of 1,200 feet. In 1885 the total yield of these wells was 6,000,000 cubic feet; in 1889 but 1,642,500 feet.

Shortly after gas was found at Fredonia, Judge Campbell, of Westfield, New York, used natural gas from a spring near by for the lighthouse at Barcelona, a small harbor on Lake Erie. The contract to supply the lighthouse was abandoned in 1856, though the gas is still used, supplying all the churches, public halls, schools, and about 20 families. In 1827 a contract was made by Walter Smith, of Dunkirk, New York, with the government to supply the lighthouse at that place for a term of years, and a ½-inch pipe was laid 2½ miles from the Matteson gas spring at Fredonia; but owing to the size of the pipe no flow was obtained, and after many trials of other means of transportation the enterprise was abandoned.

The existence of marsh gas, the modern natural gas, was well known to the earliest explorers of the Kanawha valley. In 1775 Washington, while on a visit to the Kanawha to locate lands granted him for his military services, set apart and deeded to the public forever a square acre of land on which was located a "burning spring". Through some informality his intention in this gift was frustrated. The "burning spring" mentioned by Mr. Jefferson in his "Notes on Virginia" was probably this same spring.

The boring for salt water in the Kanawha valley, which was begun in the winter of 1807–1808, not only resulted in finding brine, but nearly every salt well became a gas well, the gas in many cases jetting the water into the air and taking fire. From wells only 15 to 20 feet deep the gas escaped in quantities, burning a long time. As early as 1815 a gas well was struck within the present city limits of Charleston. This well was bored for salt, and upon striking the gas reservoir it gave out a great volume of gas, which caught fire from a grate near at hand. Those boring the well conceived that it would be reckless to drill deeper, and abandoned it.

It is worthy of notice that many of the methods and appliances that have made deep well boring possible were developed and perfected at these salt gas wells. The chisel bit, the "jar", sectional tubing, made then of tin and soldered, instead, as now, of iron with screw joints, and the "seed bag" were used at the Kanawha valley salt wells before oil was found in western Pennsylvania.

So far as has been ascertained, the first use of gas in manufacturing was in "boiling salt", in the Kanawha valley of West Virginia, by William Tompkins in 1841, some 20 years after its use for lighting at Fredonia, New York. While boring a well for salt a short distance up the Kanawha river from the "burning spring" above alluded to, he struck a large and steady flow of gas, which was strong enough to force the salt water into a reservoir, from which it could be distributed to his furnace pans. He determined to use this gas as a fuel to "boil his furnace", and for this purpose extemporized a gasometer from a hogshead placed over the reservoir. Into this primitive receptacle he conveyed the escaping water and gas, the water falling into the reservoir. The gas, conveyed through a pipe to the mouth of his furnace, a "salt block" 100 feet long by 6 feet deep and 4 wide, produced an intense heat under the whole row of kettles. In 1843 gas was struck in a well bored near Mr. Tompkins' well at the depth of 1,000 feet. The force of the gas was so great as to throw a column of salt water 150 feet above the mouth of the well. This is the first "gasser" and "roarer" on record.

From the beginning of the drilling of oil wells in Pennsylvania in 1859 natural gas has been obtained in greater or less quantities, either accompanying the oil or in wells that were true gas wells; that is, yielding little or no oil. In most of the flowing oil wells the pressure which forces up the oil is this gas. The attention of oil producers was first directed to the danger connected with this gas by the explosion at the Rouse well, on Oil creek, one of the first flowing wells struck. 18 persons lost their lives by the explosion of gas at this well. At first this gas was considered not only of no value, but a dangerous nuisance, and was carefully led away from the wells in pipes and burned to get rid of it. After a little, however, it began to be used for fuel under the boilers in drilling and pumping and for light and fuel in the towns and villages in the immediate vicinity of the wells. The proportion of the gas so used, however, until some 2 years since was very small. The apparatus for collecting this gas for use in raising steam in drilling was at first quite simple. The oil and gas as they came from the well were led into a barrel or hogshead, the oil being drawn off by a pipe at the bottom and the gas by a pipe at the top.

The so-called Leechburg gas well, the gas from which was the first used in iron making, was bored for oil in 1870 and 1871, the gas vein being struck in the latter year at a depth of 1,200 feet. This well is situated on the south side of the Kiskiminitas river, in Armstrong county, Pennsylvania, opposite Leechburg. For some months the gas was allowed to escape, without any attempt to utilize it, until in April, 1873, Messrs. Rogers & Burchfield bought the well and piped the gas across the river to their works on the north bank. The gas was accompanied by a large flow of salt water. To separate the gas from the water it was conveyed from the well by a 5⅝-inch pipe into a common cylindrical boiler, furnished with an ordinary safety valve. The water was drawn off at the bottom of the boiler through a quarter-inch pipe, it being forced out in a spray. From the top of this boiler receiver the gas was led across the river and distributed by a network of pipes through the mill. As noted above, this was the first use of gas in iron works.

The first gas piped any considerable distance was from what is known as the Harvey well, near Lardens mills, in Butler county, Pennsylvania. This at the time it was bored, in the fall of 1874, was the most powerful gas well in the section. In 1875 it was purchased by the Natural Gas Company, limited, the first natural gas company formed, and piped 17 miles, through a 6-inch pipe made of iron one-fourth of an inch thick, to the mill of Messrs. Spang, Chalfant & Co., at Etna, near Pittsburg. The gas was turned into the pipe in October, 1875, and traversed the 17 miles in 20 minutes, the observed pressure at the wells being 119 pounds.

The first use of gas in glass making appears to have been at the Rochester tumbler works, at Rochester, Pennsylvania. It has not been possible to learn the date of this use.

In 1883 Mr. J. B. Ford, at the Pittsburg plate glass works, at Creighton, Pennsylvania, succeeded in securing a supply of gas for his glass works, since which time these works have been run entirely by natural gas.

The most important fields in western Pennsylvania are the Murrysville and Grapeville, both in Westmoreland county. The first of the wells in the Murrysville district, Haymaker No. 1, was put down in 1878, and for 5 years its product was allowed to go to waste. In 1883 other wells were drilled, and pipe lines were laid to East Liberty and Pittsburg, which mark the beginning of the present extensive use of natural gas in that city.

It was not until 1883, with the piping of the gas of the Murrysville district to Pittsburg and the striking of gas in the Westinghouse well at Homewood, Pittsburg, that natural gas began to be used extensively as a fuel. Prior to this time its use had been exceptional and at isolated works, but with the piping of this gas and the striking of the Westinghouse well the extension of its use became instant and well-nigh universal for manufacturing purposes in the neighborhood of Pittsburg. Its introduction into the rolling mills of Wilson, Walker & Co. and Shoenberger & Co. and the flint glass furnace of the Fort Pitt glass works was rapidly followed by its adoption in other establishments until (in 1889) few of the important manufactories of Pittsburg that are so situated as to obtain a supply of gas cheaply use any other fuel.

The Grapeville district was first developed in 1885. The first well in the Hickory district, Washington county, known as the McGuigan, was struck in March, 1882. The gas was allowed to waste for more than a year, when a 6-inch main was laid to Birmingham, a part of Pittsburg, situated on the south side of the Monongahela. The line was 22 miles long. In 1884 2 other wells were struck, and later 2 more. The supply from these 4 wells was enormous. A second portion of the Washington county field is the Cannonsburg. Some 5 wells had been drilled at the close of 1885. In that year 5 gas wells were drilled in the town of Washington. These supplied the town with fuel. The gas from the wells of the Hickory, McGuigan, and Cannonsburg districts, all lying a little northwest of Washington, have been piped to Pittsburg.

Gas first began to be utilized in manufacturing in Erie, Pennsylvania, about 1868, by the Jarecki Manufacturing Company. The first well was put down some 600 feet, and yielded largely at first, but the amount steadily decreased. This has been the history of all the wells in this region, the pressure at some being at first as much as 50 pounds to the square inch, but rapidly falling off and becoming extremely irregular. At the Erie furnace of Messrs. Rawle, Noble & Co. an attempt was made in 1874 to use natural gas in a blast furnace. This gas was from a well 800 feet deep, with a pressure of 25 pounds. It was driven into the furnace by its own pressure through a three-eighths inch pipe inserted in the tuyères. Its use was not a success.

In Ohio the first use of natural gas appears to have been at Findlay, for domestic purposes. Natural gas had been known to exist in this place from its first settlement, and was met with in digging cellars, wells, and sewers, and in springs and rock crevices. Explosions in excavations were by no means infrequent. The gas collected from a well dug for water was introduced into a house in Main street in 1838, and has been burned ever since.

The first important developments in the Findlay field were in 1884, when the Findlay Natural Gas Company struck gas at a depth of 1,100 feet. The drilling in of the first important well took place in 1886.

The first of the Neff wells, referred to elsewhere, the gas from which was the first used to make lampblack, was drilled in 1865.

The first wells drilled in the Ohio shale were put down in 1860, at the time of the Pennsylvania oil excitement.

The first discovery of natural gas in the neighborhood of East Liverpool, Ohio, a locality noted for its manufacture of pottery, was in 1860 while drilling for oil. Gas was found at several places in the vicinity at the same time. At Jethro, a locality within the town limits of East Liverpool, 2 gas wells were struck; also 1 on Balls island, in the Ohio river, opposite the east end of the town; 1 on the McKinnon farm, east of the Cleveland railroad depot; 1 on the Virginia shore, directly across the river from this depot, and several others of but little note. The gas was struck at 400 to 600 feet from the surface. The Jethro well produced strong salt water in abundance, which was thrown out in strong volume by the pressure of the gas. A short time after the well was struck evaporating pans were put up and the gas utilized in evaporating salt water, which was also thrown out of the well by its pressure. Shortly after this utilization of the gas at the Jethro well the gas from another well at Little Beaver bridge, 4 miles east of East Liverpool and near the Pennsylvania state line, was utilized in the same way. It appears from this, therefore, that as early as 1860 natural gas was used in evaporating salt in the East Liverpool district. In October, 1873, Mr. Homer Laughlin sunk a well at his pottery within the town limits, this being the first well bored especially for natural gas. Its product was also the first gas utilized in the East Liverpool region for fuel and light, with the exception of the gas from the two wells above mentioned, which was utilized in salt manufacture. Two years later, or in 1875, other parties in East Liverpool bored wells, the gas from which was also used for fuel and light. These wells, however, have never been large producers, and have only furnished gas for light and fuel for small fires. Some years ago, at a time when a number of wells had been freshly bored, the gas from them was used in firing a very few kilns of pottery, a large number of the best wells, owned by different persons, being coupled or connected together. The supplies from these wells have been gradually falling off.

The first well bored in the Macksburg field, in 1877, yielded dry gas.

Gas was first discovered in Champaign county, Illinois, in 1853. At Litchfield, in Montgomery county, where the most important developments in this state have been made, it was first discovered in 1882, but the field assumed no importance until 1885.

The history of natural gas in other localities is of but little commercial importance.

## ORIGIN OF NATURAL GAS.

Petroleum and natural gas have a common origin. They are both members of that most wonderful series of chemical compounds known as the paraffins, of which paraffin wax may be regarded as a representative of the solid portion of the series, petroleum of the liquid portion, and natural gas as the best known gaseous member. The origin of petroleum and natural gas is discussed somewhat at length in the report on petroleum.

## GEOLOGICAL DISTRIBUTION OF NATURAL GAS.

While it is true that natural gas has been found in the strata of every geological age, from the drift down to the potsdam, it has been chiefly in the Trenton limestone of Ohio and the paleozoic strata of the upper coal measures of Pennsylvania that the great deposits of natural gas have been struck. The highest stratum in which any considerable quantity of gas has been found in Pennsylvania is the Homewood sandstone, the highest of the 3 recognized members of the Pottsville conglomerate. The lowest are the Kane sand and the sand of the Roy and Archer gas pool of Elk county. According to Mr. Carll, the geological position of the latter sand is 1,800 feet below the horizon of the Murrysville sand. As the question of the geological distribution of natural gas will be discussed in connection with the report on the several gas fields, it is not necessary to enter into a further discussion of the subject here.

## COMPOSITION OF NATURAL GAS.

Natural gas is composed chiefly of several of the hydrocarbons of the paraffin series, together with nitrogen, a small portion of carbonic acid, and traces of oxygen. Free hydrogen in minute quantities is found in certain gases. Methane, or marsh gas, constitutes from 50 to 90 per cent or more of Pennsylvania natural gas. In addition to the hydrocarbons of the paraffin series, olefiant gas or other members of the olefine series are sometimes found.

The best and most thorough analyses of natural gas yet made are by Professor Francis Phillips, of the Western University, Pennsylvania. In the following table are found the analyses of 9 of these gases. The Fredonia gas is from the mains of the Fredonia Natural Gas Light Company, at Fredonia, New York. The Sheffield wells are in Warren county, Pennsylvania, and supply Sheffield, Iona, Brookston, Clarendon, Warren, Corry, and Erie, Pennsylvania, and Jamestown, New York. The Kane well is in Kane, McKean county; the Wilcox well is in Wilcox, in the same county; the Speechley well is near Oil City, in Venango county; the Lyons run well is at Murrysville; Raccoon creek is near Rochester, Pennsylvania; Baden is in Beaver county, near Rochester, while the Houston well is 2 miles south of Cannonsburg, in Washington county.

ANALYSES OF PENNSYLVANIA NATURAL GAS.

| CONSTITUENTS. | Fredonia. | Sheffield. | Kane. | Wilcox. | Speechley. | Lyons run, near Murrysville. | Raccoon creek. | Baden. | Houston. |
|---|---|---|---|---|---|---|---|---|---|
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 99.92 | 100.00 | 100.00 | 100.00 |
| Nitrogen | 9.54 | 9.06 | 9.79 | 9.41 | 4.51 | 2.02 | 9.91 | 12.32 | 15.30 |
| Carbon dioxide | 0.41 | 0.30 | 0.20 | 0.21 | 0.05 | 0.20 | Trace. | 0.41 | 0.44 |
| Hydrogen | ........ | ........ | ........ | ........ | 0.02 | ........ | ........ | ........ | ........ |
| Ammonia | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | Trace. |
| Oxygen | Trace. | Trace. | Trace. | Trace. | Trace. | Trace. | Trace. | Trace. | Trace. |
| Sulphureted hydrogen | ........ | ........ | ........ | ........ | ........ | ........ | Trace. | ........ | ........ |
| Paraffins | 90.05 | 90.64 | 90.01 | 90.38 | 95.42 | 97.70 | 90.09 | 87.27 | 84.26 |

The paraffins contained in the above gas samples have the following composition by weight:

| CONSTITUENTS. | Fredonia. | Sheffield. | Kane. | Wilcox. | Speechley. | Lyons run, near Murrysville. | Raccoon creek. | Baden. | Houston. |
|---|---|---|---|---|---|---|---|---|---|
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Carbon | 78.14 | 76.69 | 76.77 | 76.52 | 77.11 | 74.96 | 76.42 | 76.48 | 76.68 |
| Hydrogen | 21.86 | 23.31 | 23.23 | 23.48 | 22.89 | 25.04 | 23.58 | 23.52 | 23.32 |

The analysis of Trenton limestone gas, given by Professor Edward Orton in his report on Ohio gas, is as follows:

COMPOSITION OF NATURAL GAS FROM THE TRENTON LIMESTONE, OHIO.

| CONSTITUENTS. | Findlay. | Fostoria. | Saint Marys. |
|---|---|---|---|
| Total | 100.00 | 100.00 | 100.00 |
| Hydrogen | 1.64 | 1.89 | 1.74 |
| Marsh gas | 93.35 | 92.84 | 93.85 |
| Olefiant gas | 0.35 | 0.20 | 0.20 |
| Carbonic oxide | 0.41 | 0.55 | 0.44 |
| Carbonic acid | 0.25 | 0.20 | 0.23 |
| Oxygen | 0.39 | 0.35 | 0.35 |
| Nitrogen | 3.41 | 3.82 | 2.98 |
| Sulphureted hydrogen | 0.20 | 0.15 | 0.21 |

## ACCUMULATION OF NATURAL GAS.

Whatever theory may be accepted as to the origin of natural gas, there are certain conditions necessary to its accumulation and storage, and if either of these is absent no large supply of gas can be expected. Small amounts of gas can be discovered without the presence of these conditions, but the wells will yield only a small supply, and that supply will be very soon exhausted. These vital conditions are three: (1) reservoir; (2) cover; (3) structure.

Gas is not stored, as often supposed, in large cavities or caves in the interior of the earth's surface, but chiefly in porous sandstones and limestones, gas as well as oil being found in the small interstices between the grains or in the pores.

The reservoir rock in western Pennsylvania is almost always a sand rock. The storage reservoir in Ohio is the Berea grit and the Clinton and Trenton limestones. Some little oil is found in shale, but the two great reservoirs in which the natural gas supply of the United States is stored are the sand rocks of western Pennsylvania and the Trenton limestone of northwestern Ohio and eastern central Indiana.

It is evident at once that were the whole structure above these reservoir rocks permeable, either through its entire structure or at points, by reason of the breaks and fissures in the strata, the gas would constantly escape from the reservoir and it would soon be drained out. This is a phenomenon that is constantly noticed in connection with gas springs. The gas is leaking from the reservoir; hence it is evident that there must be a cover or cap to this reservoir to hold the supply in place, and that this cap must be impervious to the gas, or practically so, either from the absence of porosity or the absence of breaks and fissures. This cover is usually a shale, and in every important gas territory the reservoir rock is capped by a shale cover, which has retained the gas in place until the cover has been tapped by the drill. In Ohio, for example, the Cuyahoga and Berea shales cover the Berea grit, the Niagara shale the Clinton group, and the Utica shale the Trenton limestone. As a rule, with of course limitations, the deeper the storage rock and the closer to it the shale or cover the larger the deposits of gas and the greater the chance for their permanence.

A third factor comes in here, which is termed structure, or the arrangement of the rock that contains the gas. The existence of arches and troughs, or, in geological language, of anticlines and synclines, has long been noticed in connection with drilling for petroleum, and recently in drilling for natural gas, as well as their influence upon the storage of these hydrocarbons. The most effective statement of this influence of structure, or, as it may be called, the "anticlinal theory", was made by Professor I. C. White, of Morgantown, West Virginia. Though his statements were called in question, his theory commended itself to practical men, and its adoption led to the location of a considerable number of natural gas wells far in advance of the developments of the drill. This theory simply asserts that oil, and more especially gas, is to be found stored most largely in the apex of these anticlines. The great reservoir of the Trenton limestone gas in the Ohio field is found in an enormous anticline, as is noted in discussing the Trenton limestone in connection with the report on Ohio.

A fourth necessity in connection with the production of gas is pressure. Without stopping to discuss the subject at this place, as it will be discussed elsewhere, it may be said briefly that salt water is found on the outer boundary of gas and oil fields, and it is to the presence of this water that the pressure of the oil and gas is ascribed by most of the geologists of Ohio and Indiana, though most of the Pennsylvania geologists question its sufficiency. Dr. Phinney, of Indiana, claims that the initial pressure of a great many gas wells is about that of the weight of a column of water equal in height to the depth of the well.

## PRESSURE OF NATURAL GAS.

The statements as to the pressure of the early gas wells were usually estimates based upon no accurate observations; indeed, there was no method of accurately arriving at this pressure available to the drillers of the first wells. Very soon, however, proper gauges were prepared and observations and measurements made; but even under these circumstances no uniform system was adopted, so that though a statement as to the pressure or production of a given well might be a fairly correct approximation as to that well under the conditions of the test, yet a comparison of the results at this well with those from another well made under different conditions would be without the least value.

In a general way it may be said that the highest actually observed and measured pressure has been in the neighborhood of 800 pounds to the square inch, closed pressure, the pressure being allowed to accumulate for a minute. In the first wells in the Findlay field the registered pressure was about 450 pounds; in the Murrysville field it reached 500 pounds; in the Indiana field the pressure was 400 to 500 pounds. It has been observed that with some few exceptions there is a pressure that is normal to each district, and that all wells in the same district ultimately show the same closed pressure; that is, the pressure measured when the well is closed and gas not escaping. Wells are sometimes measured by their flowing pressure; that is, the pressure shown on the gauge attached to the pipe through which the well is discharging gas into the air or into mains. Often when a well is first struck, owing to local causes, the pressure and production will be greater than the normal pressure of the district, but it is ultimately reduced to the normal figure. It is not to be inferred from this, however, that all wells of the same diameter and with the same ultimate pressure and located in the same district have the same production. Quite the contrary. In some wells the normal pressure, say 500 pounds, will be reached within a minute after the wells are closed; in others the normal pressure of the district will not be reached for days. It is evident that the well which reaches the normal pressure in a minute will be a greater producer than the one requiring hours to reach this pressure. All the wells in the neighborhood of Pittsburg had originally about the same normal closed pressure, that is, 500 pounds, but the wells in the several subdistricts in that vicinity show a great difference in the time required to reach this pressure, and consequently show great difference as producers. The same is true in the Findlay district. For example, the actually observed daily production of 4 wells in this district, as given by Professor Orton, is as follows:

OBSERVED DAILY PRODUCTION OF GAS WELLS IN FINDLAY, OHIO.

| | CUBIC FEET. |
|---|---|
| Karg well | 12,080,000 |
| Cory well | 3,318,000 |
| Briggs well | 2,565,000 |
| Jones well | 1,159,200 |

The original pressure in the Pittsburg district, as stated above, was about 500 pounds. In the Washington district, in the original wells, the pressure was about the same, but it has been found that gas from the different horizons, there being 4 in the Washington district, gives different pressures. In the Murrysville district the pressure is about the same as in the Pittsburg district. In the Wilcox district, in McKean county, Pennsylvania, the first pressure was about 575 pounds; in Butler county, 450 pounds; in Allegany county, New York, 450 pounds, and in Illinois 400 to 450 pounds, which was rapidly reduced to 125 pounds. This original pressure is rapidly declining. Professor Orton has paid more attention to this subject than any other of our geologists. He found the rock pressure in the original pioneer well in the Findlay, Ohio, district to be 450 pounds. In 1886 the pressure reached little, if any, above 400 pounds; during 1887 the fall was very gradual, the gauges marking 370 and 380 pounds; in May, 1889, the pressure had fallen to 250 pounds in independent wells, and in August of the same year it did not exceed 200 pounds. The wells in the city fell as low as 170 pounds at one time. Professor Orton's tabulated statement of the pressure of the wells in Findlay is as follows:

RATE OF DECLINE IN PRESSURE OF FINDLAY (OHIO) GAS WELLS.

| | POUNDS. |
|---|---|
| 1885 (original) | 450 |
| 1886 | 400 |
| 1887, August | 360 to 380 |
| 1889, May 1 | 250 |
| 1890, May 1 | 170 to 200 |

In the Stuartsville district the decline was as follows:

| | POUNDS. |
|---|---|
| 1888 | 450 |
| 1889, June | 385 |
| 1889, August | 365 |
| 1889, October | 325 |
| 1890, May | 275 |

In Bloomdale the rock pressure in 1887 was 400 to 465 pounds; in July, 1889, it had dropped to 375 and 390 pounds. A copy of a paper read at the meeting of the American Philosophical Society by Professor J. P. Lesley, state geologist of Pennsylvania, gives the following data concerning the gas pressures of the Grapeville field, from which it will appear that wells struck in February, 1886, had a pressure of 460 pounds. The same wells had February 2, 1891, a pressure of 65 to 70 pounds, while the initial pressure of wells struck in January, 1889, was 75 pounds.

MINUTE PRESSURE AT VARIOUS DATES AT GRAPEVILLE (PENNSYLVANIA) GAS WELLS.

[Pounds.]

| Number. | Name. | Depth. (Feet.) | Struck gas. | At first. | April 27, 1889. | December 16, 1889. | May 26, 1890. | November 3, 1890. | December 1, 1890. | January 5, 1891. | February 2, 1891. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Klingensmith | 1,100 | February 13, 1886 | 460 | 390 | 250 | 180 | 100 | 95 | 75 | 65 |
| 2 | Henry | 1,133 | June, 1886 | 460 | 380 | 260 | 170 | 105 | 100 | 75 | 70 |
| 3 | Moore | 1,149 | June, 1886 | 460 | 390 | 260 | 175 | 100 | 95 | 75 | 65 |
| 4 | Welker | 1,144 | October, 1886 | 460 | 380 | 260 | 170 | 105 | 100 | | |
| 5 | Brown | 1,224 | May, 1887 | 460 | 390 | 260 | 180 | 100 | 95 | 75 | 65 |
| 6 | Ferree | 1,312 | August, 1887 | 460 | 380 | 240 | 170 | 100 | 100 | 75 | 70 |
| 7 | Minsinger | 1,466 | November 21, 1887 | 410 | 390 | 240 | 170 | 95 | 85 | 55 | 40 |
| 8 | Shutts | 1,468 | February 13, 1889 | 380 | 390 | 250 | 165 | 100 | 85 | 70 | 60 |
| 9 | Kipple | 1,360 | November 30, 1889 | 260 | | 260 | 165 | 100 | 95 | 75 | 65 |
| 10 | Sylvis | 1,357 | January 13, 1890 | 235 | | | 170 | 105 | | 75 | 75 |
| 11 | Truxel | 1,267 | February 20, 1890 | 225 | | | 180 | 100 | | 75 | 75 |
| 12 | Byers | 1,350 | October, 1890 | 125 | | | | | | 65 | 60 |
| 13 | Agnew | 1,420 | January, 1891 | 75 | | | | | | | 65 |

Calculating the average rate per day of the observed decrease, it is found to be as follows:

From April 27, 1889, 646 days, 321 pounds, 2.012 pounds per day.
From December 16, 1889, 413 days, 188 pounds, 2.197 pounds per day.
From May 26, 1890, 252 days, 107 pounds, 2.355 pounds per day.
From November 3, 1890, 91 days, 36 pounds, 2.528 pounds per day.
From December 1, 1890, 63 days, 30 pounds, 2.1 pounds per day.
From January 5, 1891, 28 days, 7 pounds, 4 pounds per day.

## STORAGE OF GAS.

The waste of gas, especially in western Pennsylvania and in the Ohio fields, in which high-pressure gas is found, was at first simply enormous, the amount reaching a total so marvelous that it is impossible to form any accurate conception of it. It is estimated, for example, that the waste of gas at the Haymaker well No. 1, the first struck in the Murrysville district, during the five years when it was not used was the equivalent of 1,000 tons of coal a day. The Harvey well, the gas from which was piped to Spang, Chalfant & Co.'s in 1875, blew millions of feet of this valuable fuel into the air before it was utilized, and the gas from the McGuigan well, in the Washington county district of western Pennsylvania, was not used for over a year after it was struck. The waste of gas in Ohio and Indiana in the early history of these fields was simply incalculable. Very soon, however, measures were taken to stop this form of waste. At first it was sought to confine the high-pressure gas by placing caps with gates on the top of the well casing, but it was found in many instances that the pressure rapidly accumulated to a point where there was danger of blowing the casing out of the well, and this system was temporarily abandoned.

Two methods have been adopted for storing gas, one adapted to territory where the prospect of obtaining gas by drilling is reasonably certain, and the other applicable to all wells of ordinary pressure. The first consists simply in drilling as near as possible to the depth at which the gas reservoir is supposed to be and then "holding the well", as it is termed, and bringing it in by drilling a little deeper whenever the demand for gas or the decrease in other wells requires it. Recently, however, a method of storage by packing the wells has been adopted. This confines or stores the gas in its own reservoirs. The packer most largely in use is the same that is used in oil wells, only in putting the packer together for gas wells it is necessary to use extra precautions to prevent the gas from blowing off the rubber. This is done by fitting the rubber tightly to the inner pipe and wiring the end securely in place. One packer used is a rubber annulus from 8 to 20 inches in length, with an outside diameter half an inch less than the bore of the well. The inside diameter is large enough to permit it to go over the tubing used in the well. The pipe going through the rubber is screwed into a flange at the upper end, the flange being large enough to cover the end of the rubber. Then another flange is slipped over the lower end of the pipe the same size as the rubber, thus making a slip joint. The outside of the lower flange is threaded, so as to screw on to a sleeve which is large enough for a coupling to slide in. The coupling is screwed on to the lower end of the pipe going through the rubber. The coupling makes a pipe to engage with the shoulder on the flange which supports the anchor or lower part of the tubing while being lowered into the well or removed from the well, thus making a telescopic joint. Enough tubing is screwed together before the packer is screwed on to bring the packer as high from the bottom of the well as is desired. Then the packer is screwed on the tubing, then the balance on the top of the packer, until the bottom of the well is reached. One joint of the anchor or lower tubing is perforated to admit the oil or gas into it when the packer is expanded to the wall of the well. When the anchor strikes the bottom of the well the weight of the tubing above the packer comes on the rubber and forces the pipe into the sleeve or telescopic joint and presses the rubber between the two flanges and out to the wall of the well, thus making the oil or gas below the packer go into the tubing at the perforation, and thence to the top through the pipe. Of course the casing of the well is anchored down to prevent blowing out. While it may be fairly assumed from the statements and evidence that gas can be retained in a well without wasting, no means as yet seems to have been devised for saving the gas that escapes from the pipe after it has left the well.

Another method is to securely anchor the casing by attaching it to a framework securely bolted to the rock adjacent. In such cases the gas is held in place by a valve screwed on the top of the casing, and as the demand increases or diminishes the valve is opened or closed.

## TRANSPORTATION OF NATURAL GAS.

When natural gas was first struck in quantity the location of manufactories that were to use it was such as to require the conduction of the gas some distance, and it still holds that most of the gas consumed in manufacturing and for domestic purposes is conveyed to considerable distances from the wells to the points of consumption. The conduits used are iron pipes. For the smaller conduits wrought-iron welded pipes are used; for the larger, in some cases, riveted wrought-iron pipes, and in others cast-iron pipes. The great pressure at first complicated the matter of conveyance, making it much more difficult to prevent leakage, though at the same time this great pressure made it possible to conduct gas to a greater distance than if the pressure had been less.

In view of the danger from leakage great precautions have been taken in laying pipes to provide, first, against leakage as far as possible, and, second, to provide means of removing that gas which may escape before it shall accumulate in sufficient quantity to be dangerous. In the system of laying pipes adopted by the Philadelphia Company in Pittsburg each joint of the pipe, which it is assumed will sooner or later leak more or less, is surrounded by a conical pile of broken stone inclosed in a covering of thick tarred paper, through which rises a vertical trumpet-mouthed pipe, intended to gather the gas which may leak from the joints into the interstices of the broken stones and to convey it away by a small pipe, which extends horizontally over the main pipe which conveys the main volume of the gas. This leakage or escape pipe is led at intervals of about 300 feet into a lamp-post, where the gas may escape without harm into the open air, or, as is frequently the case, may be lighted for the purpose of illumination. Other methods have been adopted, but in all cases great care has been taken to provide against the danger resulting from leakage; and in view of the enormous amount of gas transported and the ignorance as to the necessary conditions to secure safety when many of the pipes were first laid, also in view of the explosive character of the gas when mixed with the proper proportion of air, the small number of accidents that have happened is truly remarkable.

## NATURAL GAS AS AN ILLUMINANT.

As is elsewhere stated, the first use of natural gas in the United States was as an illuminant at Fredonia, New York, and yet, as indicated by analyses and practical tests, it is a heating rather than an illuminating gas. The illuminating hydrocarbons are either in small quantities or entirely wanting. There is occasionally a little olefiant gas present, rarely exceeding 1 per cent, however. This gas is chiefly marsh gas. Marsh gas is high in heating power, but burns with a yellowish flame, not giving much light. As a rule, the lighting power of natural gas is by no means low, though lower than coal gas usually furnished to consumers. The candle power of the natural gas of the Pittsburg district is usually given as 8, and of the Findlay (Ohio) from 12 to 14.

From the above statement it will be noted that natural gas, though in some instances it is as high in candle power as 12, is not as good an illuminant as coal gas, and is not usually employed as an illuminant where ordinary gas from coal can be procured at reasonable figures. The most careful and interesting experiments made with the use of natural gas as an illuminant were at Findlay, Ohio, under the direction of Mr. E. B. Philipp. With a 36-hole lava tip argand burner 12.57 candle power was obtained. A flat flame Bray burner gave a candle power of 10.85, while a special bat's wing burner gave a candle power of 11.57. These tests were made with the crude gas, but by partially purifying it by passing it through lime boxes, removing the carbonic acid and sulphureted hydrogen, the candle power was increased to 13.77. Probably the best results that have been obtained in the use of natural gas as an illuminant have been in connection with the various styles of burners using a hood or mantle, in which the light is derived from the incandescence resulting from the heating of the hood or mantle. The Welsbach is an example of this class of burners and the Campbell another. Some good results have also been obtained by using various forms of regenerative burners, such as the Siemens and the Haupt. The Todd burner, which is constructed on the principle that there is not enough carbon in the gas to give sufficient illumination under ordinary methods of burning, has also been used. The air before it comes in contact with the gas is heated to a very high degree, and, striking the gas, burns the hydrogen at once, rendering the carbon incandescent.

## EXHAUSTION OF GAS.

That the supply of natural gas is limited and will ultimately be exhausted has never been questioned. When the great reservoirs of western Pennsylvania, northwestern Ohio, and eastern Indiana were first struck the supply was so bountiful that many were led to believe that it was practically inexhaustible; at least there is no other sensible explanation of the wastefulness with which it was used at first or the readiness with which manufacturing plants were located in the natural gas regions, away from cheap supplies of other fuel. But even while these parties by their action expressed their confidence in the continuance of the supply of gas at least for the near future, they were ready to concede that ultimately it would be exhausted. The question at issue was, how long could the supply be depended upon?

In the early history of natural gas, say in 1884 and 1885, there were various theories advanced as to the origin of it. The belief as to the continuance of the supply of gas depended somewhat upon which of these theories was accepted. They were known generally as the storage theory and the continuous production theory. The advocates of the storage theory asserted that the supply would be exhausted when the gas in the storage reservoirs had been consumed. The advocates of the continuous production theory, while they claimed that the supply was being added to by production going on continuously at a point below the storage reservoirs, yet conceded that it was not probable that the supply could be maintained in the face of the enormous consumption by any probable rate of production that is at present going on in the earth's interior. The advocates of the latter theory of course held that as production was continuous the day of exhaustion was further in the future than was admitted by the advocates of the storage theory, and that even when the vast storehouses that existed in the earth's crust prior to their being tapped were exhausted production would still continue and gas be supplied, though in smaller quantities.

The statistics of production of the census year 1889 show that the period of exhaustion of supply had been entered upon and that the day had passed when this wonderful fuel could be used so wastefully as it had been in many operations, and in the very near future it would be possible to use it only for those purposes which could afford to pay comparatively high rates for the convenience of having such a fuel, or at points where the demand does not bear such a relation to the supply as it does in western Pennsylvania and the other great gas-producing districts. It is probable that at many points it will continue to be used for years for domestic purposes, but its use in large establishments demanding great quantities of fuel is in many sections of the country a thing of the past. These works can make artificial fuel gas by some one of the many known processes, at less figures in many instances than natural gas can be furnished. This is especially true at Pittsburg, where there is such a demand for gas for domestic uses and by other small consumers that the natural gas companies are refusing to continue to supply large industrial establishments except at a price that is prohibitory. Hence the use of natural gas in large industrial establishments in the Pittsburg district and others is falling off, and these works are returning to solid fuel or using artificially prepared gas.

Some interesting facts regarding the exhaustion of gas in certain fields have been observed. It is found as a rule, for example, that shallow wells, 200 to even 1,000 feet deep, whatever may be the pressure or supply when first struck, give out much sooner than what are known as deep wells. In certain fields the supply at individual wells is soon exhausted, and the amount furnished by new wells when first bored is a constantly decreasing quantity as compared with that supplied by the earlier wells. In other districts the life of wells is longer, but the earlier wells are now quite weak or entirely exhausted, and new wells sunk do not produce any such amount of gas as those at first drilled. In other districts, as the gas is exhausted, the salt water is finding its way into the wells drilled nearest to the borders of the pool in which the gas is found. Many wells in this way have been drowned out, while other wells in the district are still producing. In no district of any importance do the "great gassers" supply gas either at the same pressure or with the same volume as when first struck.

The gas areas of the country are evidently small, scattered irregularly, and hemmed in by water areas and oil areas, and if the theory of Professor Lesley is to be adopted, they are not absolutely stationary, but shift their positions slightly as the result in part of the pressure of these water and oil areas and in part of other seismic causes. This shifting of gas areas, Professor Lesley suggests, will become comparatively rapid in the direction of the working wells as the stock of gas is drawn off, and what was at first a gas flow will become changed to an oil or water field.

## CONSUMPTION OF NATURAL GAS IN THE UNITED STATES.

It is impossible to give the consumption of natural gas in the United States for 1889; but few meters were used in that year, and those chiefly for measuring gas in small quantities. For large works, consuming hundreds of thousands of cubic feet an hour, no practicable meter was available. The amount consumed at a fire, or under a single boiler, or at a given furnace might be measured with some degree of accuracy, and the amount consumed at the time of the test regarded as the average consumption; but as consumption would vary greatly, it is evident that these figures could at best be only an approximation. In the tables therefore there has been no attempt to give the number of cubic feet of natural gas consumed. The number of fires, meaning fires for cooking and warming, the number of rolling mills, steel works, glass works, and other establishments are given. Quite a number of schedules give the estimated number of cubic feet consumed. From these a very rough approximation of the total number of cubic feet of natural gas consumed in the United States can be given.

The largest producer of natural gas in the United States is the Philadelphia Company, of Pittsburg. Its statement of the number of fires, mills, and works supplied in 1889, and the estimated number of cubic feet consumed for each purpose, is as follows:

FIRES, ETC., SUPPLIED WITH NATURAL GAS IN 1889 BY THE PHILADELPHIA COMPANY.

| USES. | Number of each. | Total consumption. |
|---|---|---|
| Total | .......... | 180,000,000,000 |
| Fires for cooking and heating | 150,000 | 15,000,000,000 |
| Iron and steel mills | 30 | 65,000,000,000 |
| Glass works | 32 | 2,000,000,000 |
| Other industrial establishments | 638 | 98,000,000,000 |

This would be at the following rate of consumption by each per year:

| | CUBIC FEET. |
|---|---|
| Fires for cooking and heating | 100,000 |
| Iron and steel mills | 2,166,666,667 |
| Glass works | 62,500,000 |
| Other industrial establishments | 153,605,016 |

Through the courtesy of the same company the writer has been furnished with a very careful estimate of the amount of gas actually consumed by 21 mills at Pittsburg, based on meter tests extending over a few hours, which is given in detail on the following page.

MEASURED DAILY CONSUMPTION OF NATURAL GAS BY 21 MILLS AT PITTSBURG.

| | CUBIC FEET. |
|---|---|
| Mill No. 1 | 3,800,000 |
| 2 | 1,866,600 |
| 3 | 1,666,210 |
| 4 | 3,393,480 |
| 5 | 1,947,000 |
| 6 | 791,240 |
| 7 | 2,303,640 |
| 8 | 3,474,900 |
| 9 | 1,986,380 |
| 10 | 11,181,260 |
| 11 and 12 | 17,640,860 |
| 13 | 2,597,900 |
| 14 | 3,010,240 |
| 15 | 7,432,960 |
| 16 | 2,526,280 |
| 17 | 14,583,460 |
| 18 | 5,362,080 |
| 19 | 2,173,140 |
| 20 | 9,005,160 |
| 21 | 18,000,000 |
| Total | 114,742,790 |

This would be an average of 5,463,942 cubic feet a day, or, on a basis of 300 days in the year, of 1,639,182,600 cubic feet a year actually consumed in work. Now, as these furnaces are kept hot the entire 24 hours, including Sundays, and as these estimates were made in 1890, when gas was used more economically than in 1889, the figures, given by the Philadelphia Company in the first estimate, do not seem excessive.

Altogether, reports have been received of the estimated consumption at 33 iron mills, 32 in Pennsylvania and 1 in Ohio. These statements are as follows:

| STATES. | Number of mills. | Total consumption. (Cubic feet.) | Average consumption per mill per year. (Cubic feet.) |
|---|---|---|---|
| Total | 33 | 67,456,579,000 | 2,044,138,758 |
| Pennsylvania | 32 | 66,425,000,000 | 2,075,781,250 |
| Ohio | 1 | 1,031,579,000 | 1,031,579,000 |

The total number of iron and steel works reported as using gas in the United States in 1889 was 95, of which 73 were in Pennsylvania, 10 in Ohio, 6 in Indiana, and 6 in West Virginia. The directory of the American Iron and Steel Association, published early in 1890, gives the number of iron and steel mills in the United States using natural gas as 104. The discrepancy between the number of mills reported to the census and in the directory doubtless comes from the fact that in some cases what is reported as a mill in the census returns may be reported as two or more in the iron and steel directory, and it is also possible that the special agent has failed to receive returns from one or two small mills. The Pennsylvania works are as a rule very much larger consumers of gas than the Ohio and Indiana works. Of the 10 Ohio works, 5 are quite small steel works, using on an average not over 500,000,000 cubic feet a year. If we assume that the Pennsylvania and West Virginia iron and steel works consumed 2,000,000,000 cubic feet a year as an average, the 5 Ohio and 6 Indiana iron mills 1,000,000,000, and the 5 Ohio steel mills 500,000,000, the estimate will at least be large enough to cover the actual consumption and some wastage. This will give the following estimate of the total consumption of gas in iron and steel works in the United States in 1889:

TOTAL CONSUMPTION OF NATURAL GAS IN THE IRON AND STEEL WORKS OF THE UNITED STATES IN 1889, IN CUBIC FEET.

| STATES. | Mills. | Number of works. | Average consumption per year per works. | Total consumption for 1889. |
|---|---|---|---|---|
| Total | | 95 | 1,805,263,158 | 171,500,000,000 |
| Pennsylvania | Iron and steel | 73 | 2,000,000,000 | 146,000,000,000 |
| West Virginia | Iron | 6 | 2,000,000,000 | 12,000,000,000 |
| Ohio | Iron | 5 | 1,000,000,000 | 5,000,000,000 |
| Do | Steel | 5 | 500,000,000 | 2,500,000,000 |
| Indiana | Iron | 6 | 1,000,000,000 | 6,000,000,000 |

It is not so easy to arrive at an average consumption of gas in glass making as in some other industries. The estimate, as previously given, of the Philadelphia Company of the average consumption at each glass works (a glass works being understood to be a furnace) is 62,500,000 cubic feet per year. The consumption of 3 other Pennsylvania glass works show a total use of 158,250,000 cubic feet, or 52,750,000 cubic feet each, or about 10,000,000 cubic feet a year less, but these were at smaller works, and are evidently underestimates.

Some very important tests have been made both in Pittsburg and in Ohio as to the amount of gas consumed in glass works. Below are given the results of a series of meter tests made by the Philadelphia Company at Pittsburg glass houses. The tests continued over 160 hours in each case. Tests were made at 4 10-pot window-glass furnaces and at 7 10-pot flint-glass furnaces.

DAILY CONSUMPTION OF NATURAL GAS AT A 10-POT WINDOW-GLASS FURNACE AT PITTSBURG.

| | CUBIC FEET. |
|---|---|
| Melting furnace | 270, 000 |
| 2 blow furnaces | 60, 000 |
| 1 flattening oven | 27, 000 |
| Stoves, pot arch, sand furnace, etc | 2, 000 |
| Total | 359, 000 |

DAILY CONSUMPTION OF NATURAL GAS AT A 10-POT FLINT-GLASS FURNACE AT PITTSBURG.

| | CUBIC FEET. |
|---|---|
| Melting furnace | 164, 000 |
| 5 glory holes | 36, 000 |
| 2 leers | 32, 000 |
| 1 boiler | 24, 000 |
| Stoves, pot arches, mold ovens, etc | 2, 000 |
| Total | 258, 000 |

These are averages for every day in the month, and would make the monthly consumption of gas at a 10-pot window factory, on the basis of 30 days to a month, 10,770,000 cubic feet, and of a 10-pot flint house 7,740,000 cubic feet. This is probably under the actual figures.

In Ohio some very thorough tests of consumption of natural gas in glass houses have been made. Tests were made at 5 window-glass and bottle houses, with the following results (the figures include all the gas used per pot for 24 hours):

CONSUMPTION OF NATURAL GAS AT 5 WINDOW-GLASS AND BOTTLE FACTORIES IN OHIO.

| | CUBIC FEET. |
|---|---|
| 1 | 58, 800 |
| 2 | 60, 000 |
| 3 | 61, 200 |
| 4 | 61, 360 |
| 5 | 60, 270 |

These tests were made with the Robinson pipe-line guage. Test No. 4 in the above table shows the average run of a 10-pot window factory. The number of pots measured at the 5 factories ranged from 8 to 18. The supply pipes varied in size, being 4, 5, and 6 inches in diameter, and the pressure from 16 to 60 ounces. In view of these facts the close agreement of these measurements is remarkable; but at the same time they differ materially from the consumption at the Pittsburg factories. The consumption at the Pittsburg window factory is but 36,000 cubic feet per pot for 24 hours, as against 60,000 in Ohio. The probability is that this difference does not come from an error, but from the greater wastefulness with which gas is used in Ohio. Professor Orton, from whose report the figures concerning Ohio are taken, says: "It might be expected * * * that 40,000 cubic feet of gas would suffice for a day's run per pot; but, whether from lavish use or other causes, about 50 per cent additional is actually used. There can be but little doubt that if the glass manufacturers were required to pay 5 or 6 cents per 1,000 cubic feet by meter or gauge a large economy would at once be effected." The Ohio tests of flint-glass furnaces were made at 8 works. The results were as follows per pot for 24 hours:

CONSUMPTION OF NATURAL GAS AT FLINT-GLASS WORKS IN OHIO.

| | CUBIC FEET. |
|---|---|
| 1 | 31, 230<br>39, 270 |
| 2 | 37, 430 |
| 3 | 38, 470 |
| 4 | 40, 530 |
| 5 | 41, 230 |
| 6 | 41, 370 |
| 7 | 44, 450<br>49, 875 |
| 8 | 50, 100 |

In explanation of the disparity of results at these tests, it is stated that some of the works were run to their full capacity, while others were not. At the two factories for which two measurements are given the tests were made at different times. The figures show a consumption of from 35,000 to 45,000 cubic feet per pot per day. It will be safe to place the average at 40,000 cubic feet. And here again the great disparity between Pittsburg and Ohio measurements is seen. Pittsburg shows an average per pot for 24 hours of, say, 26,000 cubic feet, as against 40,000 cubic feet in Ohio. According to the Ohio figures a window-glass pot consumes 1,800,000 cubic feet a month and 18,000,000 cubic feet a year of 10 months. According to the Pittsburg figures the consumption is 1,080,000 cubic feet a month or 10,800,000 cubic feet a year. An Ohio flint house consumes per pot 1,200,000 cubic feet per month, or 12,000,000 cubic feet a year, while a pot at a Pittsburg house requires but 780,000 cubic feet a month, or 7,800,000 cubic feet a year.

The number of glass works reported as using gas in 1889 is 111. In some cases a works as reported has 2 furnaces, and in one case 5. The number of furnaces in these 111 works is estimated at 150. Assuming that the consumption of each furnace is 125,000,000 cubic feet, the total consumption of gas in glass making in 1889 was 18,750,000,000 cubic feet.

The number of industrial establishments in the United States other than iron, steel, and glass works reported as using gas was 2,369. These include some very large establishments, as pipe works, machine shops, foundries, brick works, electric-light plants, breweries, nail mills, wire mills, kilns for burning pottery, tiles, bricks, etc., as well as planing mills, small wood-working establishments, etc. Of these 2,369 establishments returns of the estimated amount of gas consumed have been received from 1,075, which are reported in 1889 as consuming 113,557,478,750 cubic feet, or an average of 105,634,864 cubic feet each. Of these 1,075 works, 895 were in Pennsylvania, with a reported consumption of 118,767,357 cubic feet each, 77 in Ohio, with an average consumption of 61,481,224 cubic feet each, and 103 in Indiana, with an average amount consumed of 24,527,762 cubic feet each. Assuming the average amount consumed at each industrial establishment other than iron, steel, or glass works at 100,000,000 cubic feet, the total consumption in the United States in the 2,369 works would be 236,900,000,000 cubic feet.

The number of domestic fires, or fires for cooking and heating, using natural gas in the United States is reported as 466,034. It is evident from the schedules that in some cases a domestic consumer who may have from 5 to 10 fires is counted as 1 fire, while in other cases each fire in a house is called a fire. It is estimated that the total number of fires supplied with natural gas is at least 500,000. These fires include ranges, cook stoves, furnaces, and heaters, which are large consumers, as well as grates and small heating stoves.

Returns of the estimated consumption of gas in 236,939 of these fires have been received, showing a total consumption of 40,545,338,550 cubic feet, an average of 171,121 cubic feet each per year. This is perhaps an overestimate. Returns for 190,939 fires in Pennsylvania were received, which show an average amount consumed of 121,730 cubic feet; of 30,872 fires in Ohio, with an average amount consumed of 249,792 cubic feet; while from Indiana returns for 15,128 fires were received, showing a consumption of 633,907 cubic feet. The Pennsylvania report is probably most nearly right. Assuming 125,000 cubic feet as the average amount consumed by a fire and 7 months as the average time each fire is burned, this would make the average daily consumption for the 210 days nearly 600 cubic feet per fire. This would be 50 feet per hour for 12 hours. On the basis of 500,000 fires and an average yearly consumption of 125,000 cubic feet per fire, the total amount of gas consumed in 1889 in cooking and heating would be 62,500,000,000 cubic feet.

Returns of the use of 5,482,125,000 cubic feet in pumping oil by pipe lines have been received. It is estimated that this use consumed 7,500,000,000 cubic feet.

It is also estimated that 30,000,000,000 cubic feet of gas were consumed in the oil and gas regions in drilling and operating oil and gas wells of which no record has been obtained.

Further, it is estimated that at least 25,000,000,000 cubic feet of gas were used for purposes for which no record has been kept, or of which no details have been supplied the Census Office.

From the figures given above, we have the following as the estimated consumption of natural gas in the United States in cubic feet:

TOTAL CONSUMPTION OF NATURAL GAS IN THE UNITED STATES IN 1889.

| | CUBIC FEET. |
|---|---|
| Iron and steel mills | 171,500,000,000 |
| Glass works | 18,750,000,000 |
| Other industrial establishments | 236,900,000,000 |
| Heating and cooking | 62,500,000,000 |
| Pumping oil | 7,500,000,000 |
| Drilling and operating oil and gas wells | 30,000,000,000 |
| Other uses | 25,000,000,000 |
| Total | 552,150,000,000 |

These figures are to be taken only as the best approximation possible, and are to be accepted under the conditions expressed in the discussion preceding.

This total is enormous, and shows how wastefully natural gas has been used. It is assumed roughly that

30,000 cubic feet of gas equal in heating power 1 ton of Pittsburg coal. This is not correct, but it is near enough for comparison. On this basis the natural gas consumed in the United States, as given above, would equal in heat value 18,405,000 tons of coal. The actual fuel displacement, given elsewhere, is in round numbers 10,000,000 tons. As natural gas is burned most wastefully, perhaps more than double the amount actually needed to do a given work being used, it is probable that our estimate is not too large.

## PRODUCTION AND VALUE OF NATURAL GAS IN THE UNITED STATES.

The proper unit of production of natural gas should, of course, be cubic feet, as the measurements of gas are usually in this unit. The conditions of its production, however, are such that it is utterly impossible to arrive at a correct statement of the number of cubic feet of natural gas produced. This same remark will apply to statements regarding its distribution, sale, and use. Gas in 1889 was in but few instances sold by meter. Usually so much per fire, or per furnace, or per boiler, or per pot in glass works, or per ton of iron was charged for its use, no account being taken of the amounts used.

In Ohio some attention has been paid to the measurement of the production of certain wells. Two methods have been adopted: the anemometer for small wells, yielding 1,000,000 cubic feet or less a day, and a modification of Pitot's tubes for larger wells. The use of the anemometer for this purpose was first suggested, so far as is known, by Mr. Emerson McMillin, of Columbus, Ohio, and was first used in measuring the Adams well, at Findlay, in June, 1885. The measurements obtained have been compared with those obtained by other methods and their reliability established.

The use of the modified form of Pitot's tubes was devised and worked out by Professor S. W. Robinson, of the Ohio state university.

The most carefully observed pressures and productions have been made in Ohio in the Findlay field. The actual production of wells varied in 1885 from 80,000 cubic feet at the Adams wells to 12,080,000 cubic feet at the Karg well. It was estimated from measurements that in 1886 the great wells of the Murrysville district, Pennsylvania, yielded 15,000,000 cubic feet a day on an average; the Tarentum wells about 1,500,000. In the Findlay field in 1889 the new wells produced about the same as in 1885, while in Indiana the high-pressure wells produced from 1,000,000 cubic feet upward.

In 1889 some of the wells drilled in the Trenton limestone early in the year in Upper Sandusky yielded from 1,000,000 to 1,500,000 cubic feet of gas a day, while later in the summer a large well, yielding 15,000,000 cubic feet a day, was struck. The Mellott well, near Stuartsville, had a daily production of 28,000,000 cubic feet, while one near Bairdstown is reported to have shown the amazing open pressure of 45 pounds, which would be equivalent to a daily production of 33,000,000 cubic feet; but while individual wells of greater volume than any that had ever before been drilled were found in Ohio in 1889, the Findlay field as a whole was steadily losing its pressure, and consequently its production.

While it is impossible to give the production of natural gas in the United States in cubic feet, it is possible to reach approximately the consumption of this gas, basing figures therefor upon meter tests and estimates at certain works and assuming the average of these tests and estimates as representing approximately the average consumption at each of the works of the same kind in the United States using natural gas in 1889. The number of mills, furnaces, glass works, boilers, houses, fires, etc., using natural gas has been obtained with a reasonable degree of accuracy, and in some cases the amount consumed has been measured, so that on the basis of these figures a fair approximation of the amount of gas consumed may be obtained. As the investigation into the production of natural gas really becomes an inquiry into the consumption, the measure of production being actually the amount consumed and not that wasted into the air, these figures of consumption will approximately represent the production of natural gas with the exception of that which went to waste. This consumption, as is given in the preceding table, under the heading "Total consumption of natural gas in the United States", was 552,150,000,000 cubic feet, which is equivalent to 18,405,000 tons of coal, on the basis of 30,000 cubic feet equaling in heating power 1 ton of coal.

In arriving at the value of this gas several difficulties were encountered. The most natural course to pursue would be to give as the value of this gas the amount of money actually received for it, but this would be very much under its actual value. While it is possible for companies furnishing gas to state the exact amount received during the year from consumers, there are many instances in which industrial establishments, such as iron works, glass works, etc., located in gas districts, bore their own wells and secure an ample supply of fuel at an outlay amounting only to the cost of boring the well and laying the pipe from the well to the plant, no further care or attention being required. The cost of drilling the well and laying the pipe is charged to expense, and after this no amount is charged for the gas. Further, in many localities, especially in Indiana and Ohio, a neighborhood combines to put down a well for supplying its residences, stores, etc., and the original cost, which is the total expense in connection with drilling the well and piping the gas, is distributed among the several parties, and no further charge is made for fuel. In other instances certain towns, in order to secure the location of industrial and other establishments, have furnished gas in large quantities for nothing or at a nominal rate, so that in these cases the amount received for the gas would in no way represent its value.

The best basis of calculation of the value of natural gas consumed in the United States is believed to be that by fuel displacement adopted in the yearly reports of the Mineral Resources of the United States, of the United States geological survey. The amount of coal necessary to perform a given work, that is, to raise steam in boilers, to produce a ton of iron or steel, to operate an 8 or 10 pot glass furnace, or a glasshouse containing one or more furnaces with a given number of pots, is quite accurately known, and the value of the coal or wood required to do this work is assumed to be the value of the natural gas used to perform the same work, whatever may be the amount of money paid for this gas. For instance, in Pittsburg it is quite generally conceded that it requires about 35 bushels of coal, of 76 pounds per bushel, to puddle a ton of iron, about 14 bushels to heat a ton of iron, and 12 bushels of slack to raise the steam required in a mill to produce a ton of iron.

At a rolling mill near Pittsburg the cost of fuel for making bar iron, including the cost of puddling, heating, and making steam and removing ashes, was $2.22 a ton. At a mill in Ohio producing 50 tons of iron a day the cost of coal was $200 a day. Adding to this the wages of the men who handled the coal, hauled away the cinders, etc., and the cost of grate bars and fire brick, would make the total cost of coal fuel $5.25 a ton of iron produced, while the gas was supplied to this mill for $1.90 a ton.

The cost of fuel for running a 10-pot flint glass works at Pittsburg for 45 weeks was as follows:

| | |
|---|---|
| Slack coal | $2,809.78 |
| Coke | 1,288.29 |
| Benzine for glory holes | 1,584.48 |
| Total | 5,682.55 |

It is also estimated that 40 bushels of coal per pot are enough to run a window glass plant 24 hours, which would make 400 bushels of coal for a 10-pot furnace per day, or on a basis of 30 days in a month and 10 months in the year, 120,000 bushels a year. This would be equivalent to 4,560 tons of coal. Assuming this is the average consumption of a furnace, though it is probably a little in excess of the average, and that there were 150 glass furnaces using natural gas in the United States in 1889, it would make a consumption at these 150 glass furnaces of 684,000 tons of coal. The consumption of natural gas in the glass works in the United States is given elsewhere as 18,750,000,000 cubic feet.

While in the following table of production the value of natural gas in the United States in 1889 is given by both methods, that is, the value of the gas consumed as actually returned and the value of fuel displacement, the value of the fuel displacement is regarded as the actual value.

VALUE OF NATURAL GAS CONSUMED IN THE UNITED STATES IN 1889, BY STATES, AND THE AMOUNT AND VALUE OF COAL AND WOOD DISPLACED BY THE SAME.

| STATES AND TERRITORIES. | Value of natural gas supplied and used. | COAL DISPLACED. | | WOOD DISPLACED. | |
|---|---|---|---|---|---|
| | | Tons. | Value. | Cords. | Value. |
| Grand total | $11,044,858 | 10,198,930 | $20,932,059 | 69,018 | $165,040 |
| Pennsylvania | 8,287,383 | 6,863,062 | 11,593,989 | | |
| Indiana | 1,362,472 | 716,461 | 2,002,762 | 44,888 | 72,940 |
| Ohio | 1,120,997 | 1,660,456 | 5,123,569 | 24,130 | 92,100 |
| New York | 204,325 | 130,159 | 530,026 | | |
| Missouri | 27,825 | 11,859 | 35,687 | | |
| Kansas | 13,660 | 4,538 | 15,873 | | |
| California | 12,680 | 3,517 | 12,680 | | |
| Illinois | 8,658 | 7,245 | 10,615 | | |
| Kentucky | 2,580 | 615 | 2,580 | | |
| West Virginia | 2,000 | 600 | 2,000 | | |
| Texas | 1,728 | 288 | 1,728 | | |
| Arkansas | 375 | 107 | 375 | | |
| Utah | 150 | 18 | 150 | | |
| South Dakota | 25 | 5 | 25 | | |
| Total | 11,044,858 | 9,398,930 | 19,332,059 | 69,018 | 165,040 |
| Used at pipe lines | | 100,000 | 200,000 | | |
| Used for drilling and pumping wells | | 400,000 | 800,000 | | |
| Other uses | | 300,000 | 600,000 | | |

In the above table the column headed "Value of natural gas supplied and used" indicates only the amount received by the producers for gas supplied, while the values given under "Coal displaced" and "Wood displaced" are the values of the coal or wood that would be required to do the same work as was done by natural gas.

The great discrepancy between the actual amount received and the value of the coal or wood that would be required to do the same work is noticeable. The amount received by the producers from the consumers for the amount of natural gas consumed in the United States in 1889, so far as the same could be ascertained, was $11,044,858, while the value of the coal displaced by natural gas was $19,332,059 and of wood $165,040, making a total of $19,497,099.

While the preceding table down to the "total" represents, and is intended to represent, only the totals of the figures received from the different producers of natural gas, there are certain producers from whom no returns have been received and certain uses of natural gas which have not been included in the table, which would very materially increase these figures. These uses are chiefly in raising steam for pumping oil in the different pipe lines and for the drilling and operating of oil and gas wells. Almost all of the power required for drilling gas wells has come from steam produced by natural gas. A great many oil wells have been bored with natural gas and power for pumping a great many wells furnished by the same fuel. In some cases this gas has come from the wells of large producers of natural gas. In other cases wells that are rated as oil wells supplied natural gas in small quantities, which was used for drilling and pumping. It is estimated that the fuel displaced in the United States at the oil pipe line stations by natural gas was about 100,000 tons of coal, and the coal displaced by natural gas in pumping and drilling wells was fully 400,000, and for other uses 300,000. These are very conservative estimates, but assuming that they are correct, and that the average value of this coal was $2 a ton, this would add 800,000 tons more to the amount of coal displaced and $1,600,000 to the value of the same, making the total coal displacement 10,198,930 tons and total value of the same $20,932,059. Adding to this the value of wood displaced, $165,040, there would appear as the value of natural gas consumed in the United States in 1889, measured by fuel displacement, $21,097,099.

In the following table, from Mineral Resources of the United States for 1888, is given the amount and value of coal displaced by natural gas from 1885 to 1888, inclusive:

AMOUNT AND VALUE OF COAL DISPLACED BY NATURAL GAS FROM 1885 TO 1888, INCLUSIVE.

[Short tons.]

| LOCALITIES. | 1885. | | 1886. | | 1887. | | 1888. | |
|---|---|---|---|---|---|---|---|---|
| | Coal displaced. | Value. | Coal displaced. | Value. | Coal displaced. | Value. | Coal displaced. | Value. |
| Total | 3, 131, 600 | $4, 857, 200 | 6, 453, 000 | $10, 012, 000 | 9, 859, 000 | $15, 817, 500 | 14, 063, 830 | $22, 629, 875 |
| Pennsylvania | 3, 000, 000 | 4, 500, 000 | 6, 000, 000 | 9, 000, 000 | 8, 883, 000 | 13, 749, 500 | 12, 443, 830 | 19, 282, 375 |
| Allegheny county | 2, 000, 000 | 2, 500, 000 | 4, 000, 000 | 5, 000, 000 | 5, 477, 000 | 6, 846, 250 | 7, 302, 700 | 10, 223, 780 |
| Remainder of Pittsburg district | 500, 000 | 750, 000 | 1, 000, 000 | 1, 500, 000 | 1, 610, 500 | 2, 415, 750 | 2, 447, 330 | 3, 670, 995 |
| Western Pennsylvania, outside of Pittsburg district | 500, 000 | 1, 250, 000 | 1, 000, 000 | 2, 500, 000 | 1, 795, 500 | 4, 487, 500 | 2, 693, 800 | 5, 387, 600 |
| New York | 56, 000 | 196, 000 | 60, 000 | 210, 000 | 111, 000 | 333, 000 | 125, 000 | 332, 500 |
| Ohio | 50, 000 | 100, 000 | 200, 000 | 400, 000 | 500, 000 | 1, 000, 000 | 750, 000 | 1, 500, 000 |
| West Virginia | 20, 000 | 40, 000 | 30, 000 | 60, 000 | 60, 000 | 120, 000 | 60, 000 | 120, 000 |
| Indiana | | | 150, 000 | 300, 000 | 300, 000 | 600, 000 | 660, 000 | 1, 320, 000 |
| Illinois | 600 | 1, 200 | 2, 000 | 4, 000 | 5, 000 | 15, 000 | 25, 000 | 75, 000 |
| Kansas | | | 2, 000 | 6, 000 | | | | |
| Michigan | | | 4, 000 | 12, 000 | | | | |
| Elsewhere | 5, 000 | 20, 000 | 5, 000 | 20, 000 | | | | |

From the above table, in comparison with the table previously given, showing the value of natural gas produced in the United States in 1889, etc., it will be seen that the total value of natural gas consumed in the United States from 1885 to 1889, inclusive, measured by fuel displacement, is as follows:

TOTAL VALUE OF NATURAL GAS CONSUMED IN THE UNITED STATES FROM 1885 TO 1889, INCLUSIVE, DETERMINED BY VALUE OF COAL OR WOOD DISPLACED.

| | |
|---|---|
| 1885 | $4, 857, 200 |
| 1886 | 10, 012, 000 |
| 1887 | 15, 817, 500 |
| 1888 | 22, 629, 875 |
| 1889 (*a*) | 21, 097, 099 |

*a* The figures for 1889 are corrected value instead of value given in the table.

These figures show that the highest limit of production was reached in 1888, when the total value of gas consumed was $22,629,875. This had fallen to $21,097,099 in 1889, a reduction of about $1,532,776 in the total value of gas consumed. This indicates that the decline in the production of natural gas has begun, and while the total value of gas consumed may be kept up nearly, if not quite, to the figures of 1889 by increasing the charges to consumers, it is evident that the total production will never again reach what it was in 1888

## USES OF NATURAL GAS.

The chief uses of natural gas are as fuel for heating purposes. A small amount is used as an illuminant, and a still smaller amount for the manufacture of lampblack, or carbon black, as it is sometimes called, for use in painting, as a lubricant, and especially for the manufacture of carbons for electric lighting. The complete freedom from grit of the carbons so prepared especially adapts it to use for the purpose mentioned.

In endeavoring to arrive at the uses to which natural gas was put in 1889, for the purpose of forming a basis for reaching a conclusion as to its consumption, 6 chief divisions or uses were made, as follows: first, domestic fires, including all fires for cooking and heating in houses, stores, and offices; second, iron rolling mills; third, steel works; fourth, glass works; fifth, other gas companies; sixth, other industrial establishments, including machine shops, foundries, brick works, brass works, electric-light plants, breweries, nail mills, wire mills, potteries, planing mills, etc. In the following table is given a statement of the number of fires or works as previously classified:

USES TO WHICH NATURAL GAS PRODUCED IN 1889 WAS PUT.

| STATES AND TERRITORIES. | Fires for cooking and heating. | Iron rolling mills. | Steel works. | Glass works. | Gas companies. | Other industrial establishments. |
|---|---|---|---|---|---|---|
| Total | 466,034 | 75 | 20 | 111 | 9 | 2,368 |
| Pennsylvania | 280,484 | 58 | 15 | 69 | 8 | 1,604 |
| Indiana | 109,015 | 6 | | 11 | 1 | 439 |
| Ohio | 70,050 | 5 | 5 | 31 | | 278 |
| New York | 4,362 | | | | | 11 |
| Missouri | 339 | | | | | 2 |
| Kansas | 798 | | | | | 2 |
| California | 23 | | | | | 5 |
| Illinois | 940 | | | | | 20 |
| Kentucky | 6 | | | | | 4 |
| West Virginia | 5 | a6 | | | | 1 |
| Texas | 2 | | | | | 1 |
| Arkansas | 3 | | | | | 1 |
| Utah | 6 | | | | | |
| South Dakota | 1 | | | | | |

*a* These mills procured their gas from Pennsylvania.

From this it appears that the total number of domestic fires, or those used for cooking and heating, was 466,034, of iron rolling mills 75, of steel works 20, of glass works 111, of gas companies 9, and of other industrial establishments 2,368. More than one-half of the fires were in Pennsylvania, 58 of the 75 rolling mills, 15 of the 20 steel works, 69 of the 111 glass works, 8 of the 9 gas companies, and 1,604 of the 2,368 other industrial establishments.

As stated in discussing the consumption of natural gas in the United States, it is certain that this table does not show all of the fires using natural gas, nor all of the industrial establishments burning it. It is very probable that in several cases, instead of reporting the number of fires for heating and cooking in which natural gas is used in a given town, the number of domestic consumers is reported, each consumer having two or more fires, as the report would evidently show. The number of fires for heating and cooking has been estimated at 500,000.

It is also evident from an inspection of the returns that in several cases it is known that an establishment reported as 1 establishment contained 2 furnaces, and in one case as high as 5. It is therefore believed that regarding a glass works as a single furnace the number of glass furnaces in the United States using natural gas in 1889 was at least 150. At the close of 1889, for example, there were at least 500 pots in glass works in Ohio using natural gas. On the basis of 10 pots to a furnace, this would make 50 glass furnaces instead of 31, as reported in the table.

## WELL RECORD.

The total number of wells producing natural gas December 31, 1888, was reported as 1,502, and at the close of December, 1889, 2,247. The total number of producing wells completed in 1889 was 799, and the number reported as abandoned in 1889 was 134. Adding to the number of wells completed at the close of 1888 the number of producing wells drilled and completed in 1889, and deducting from this the number reported as abandoned, we should have 2,167 as the number of producing wells at the close of 1889, whereas the number as given was 2,247. It is evident from this that there is an error in the report somewhere, but the probabilities are that the number of wells reported as producing at the close of 1889 is correct. As it would be much easier to state at the close of 1889 how many wells were producing at the close of that year than it would to state the number that had been drilled during the year, it is assumed that the number of producing wells at the close of 1889 is correct approximately.

Assuming that the statement of the number of wells producing at the close of 1888 and 1889 is correct, namely, that 1,502 were producing at the close of 1888 and 2,247 at the close of 1889, it will be seen by reference to statistics of production that, notwithstanding the increase in wells, there has been a decrease in total production of gas, indicating that, though some of the largest wells that were ever struck were completed in 1889, the production per well was very much less in 1889 than in 1888.

There were 892 gas wells completed in the United States in 1889; of these 799 were productive and 93 were dry holes. It is probable that the number of wells drilled in 1889 was in excess of the number given in the table. It was found impossible to get information from quite a number of localities where wells were drilled without finding gas. The probabilities are, however, that all of the producing wells are reported in the table. The wells from which no report was received were either nonproducers or their product was so small that they were abandoned.

At the close of 1888 there were 48 wells drilling for gas, and at the close of 1889 93 wells.

The total cost of drilling wells, including drive pipe, casing, etc., in the United States in 1889 was reported as $1,605,393. This is below the actual figure. It was impossible to secure any information concerning the cost of a number of wells which were drilled in 1889 and which were nonproducers. The cost of drilling a gas well is the same as that of drilling an oil well, with the exception of the tank at well. The expenditure for drilling has been so thoroughly discussed in the report on petroleum that it need not be reported in detail here. It varies with the depth, size of hole, strata through which it is drilled, location of well, difficulty of preparing the ground, etc. The following may be taken as a fair average cost of a 2,000-foot well drilled in the neighborhood of Pittsburg:

AVERAGE COST OF A 2,000-FOOT WELL DRILLED NEAR PITTSBURG.

| | |
|---|---|
| Rig | $550 |
| Boiler and engine | 750 |
| Drilling, at $1 per foot | 2,000 |
| Casing (2,000 feet at $0.47½) | 950 |
| Tubing (2,000 feet at $0.12½) | 250 |
| Incidentals | 300 |
| Total | 4,800 |

In West Virginia the cost would be higher than this. In other parts of Pennsylvania the cost would be less, while it is not probable that the cost of drilling wells of the same depth in Ohio and Indiana would equal these figures.

WELL RECORD, BY STATES.

| STATES AND TERRITORIES. | DRILLING WELLS. | | WELLS COMPLETED IN 1889. | | | NUMBER OF WELLS PRODUCING. | | Number abandoned in 1889. | Total cost of drilling wells, including drive pipe, casing, etc. | DETAIL OF COST. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | December 31, 1888. | December 31, 1889. | Total. | Producing. | Dry holes. | December 31, 1888. | December 31, 1889. | | | Labor. | Material. |
| Total | 48 | 98 | 892 | 799 | 93 | 1,502 | 2,247 | 134 | $1,605,393 | $346,572 | $378,590 |
| Pennsylvania | 18 | 31 | 239 | 207 | 32 | 810 | 999 | 47 | 683,709 | 208 454 | 231,824 |
| Indiana | 20 | 39 | 307 | 293 | 14 | 287 | 576 | 17 | 431,535 | 34,028 | 39,582 |
| Ohio | 4 | 10 | 196 | 180 | 16 | 287 | 448 | 38 | 331,212 | 66,836 | 81,778 |
| New York | 5 | 12 | 65 | 55 | 10 | 69 | 119 | 3 | 74,752 | 23,604 | 14,256 |
| Missouri | | | 19 | 14 | 5 | 5 | 13 | 8 | 30,000 | | |
| Kansas | | | 16 | 14 | 2 | 5 | 25 | 2 | 9,800 | 6,450 | 3,350 |
| California | | 1 | 1 | 1 | | 5 | 6 | | 5,135 | | |
| Illinois | | | 4 | 2 | 2 | 9 | 10 | 1 | | | |
| Kentucky | | | 29 | 21 | 8 | 20 | 37 | 13 | 26,750 | 1,500 | 1,000 |
| West Virginia | | | 6 | 5 | 1 | | 4 | 1 | 2,000 | 1,600 | 400 |
| Texas | | 5 | 1 | 1 | | 1 | 1 | | | | |
| Arkansas | | | 2 | 1 | 1 | 1 | 2 | 1 | 8,000 | 2,500 | 5,500 |
| Utah | | | | | | 2 | 2 | | | | |
| South Dakota | 1 | | 2 | 2 | | | 1 | 1 | | | |
| New Mexico | | | | | | 1 | 1 | | | | |
| Tennessee | | | 2 | 1 | 1 | | 1 | 1 | | | |
| Wisconsin | | | 3 | 2 | 1 | | 2 | 1 | 2,500 | 1,600 | 900 |

Taking into consideration the localities in which natural gas wells in the United States were drilled, it is believed that $4,000 a well will cover the average cost of wells drilled for natural gas in 1889, or a total of $3,568,000, which is a little more than double the amount given in the above table.

Under the heading "Detail of cost" in the above table is included only the cost of labor and material where wells were drilled by the owners and not under contract. While the totals of this labor and material are included under "Total cost of drilling wells, including drive pipe, etc.", there is also included in "Total cost" the cost of wells drilled by contract for which no figures of labor and material have been received.

## CAPITAL.

The total capital reported as invested in the production and transportation of natural gas in the United States at the close of 1889 was $59,682,154. Of this amount $12,795,715 is given as the value of lands and $46,886,439 as the value of rigs, wells, pipe lines, and other property.

The total acreage of land, both owned and leased, held by natural gas producers is reported as 564,700. Of this amount 46,802 acres are reported as owned and 517,898 acres leased. The average value per acre of this amount is $22.66. This is evidently too low a valuation, and probably comes from the fact that it is based on the land paid for leases. This question has been so thoroughly discussed in the report on the production of petroleum that it need only be referred to here. It is customary in leasing oil or gas land to pay so much bonus down for the lease, the amount varying from $5 to $50 an acre and a royalty of the gas produced. It is fair to assume (certainly it is fair in consideration of the fact that $20,000,000 worth of gas was produced from these 564,700 acres of land) that the average value of this land is at least $100 an acre.

Of the 564,700 acres of land held in the United States 467,175 acres were held in Pennsylvania, Indiana, and Ohio. This amount is certainly worth an average of more than $100 an acre, some of it considerably more. Assuming this price, $100, for the average value of all land held, the value of land would be $56,470,000, instead of $12,795,715. It is but fair to say that some of this land reported as gas land is also oil land, certain wells on the same leases producing oil and others gas.

Of the $46,886,439 reported as the value of property other than lands, $7,472,157 is given as the value of rigs, wells, etc., $31,637,284 as the value of pipe lines used in transporting the gas from wells to consumers, and $7,776,998 as the value of other property.

CAPITAL INVESTED IN THE NATURAL GAS INDUSTRY IN THE UNITED STATES IN 1889.

| STATES AND TERRITORIES. | Total capital. | NUMBER OF ACRES OF NATURAL GAS LAND. | | | | VALUE OF PLANT. | | |
|---|---|---|---|---|---|---|---|---|
| | | Total acreage. | Owned. | Leased. | Value. | Rigs, wells, etc. | Pipe lines. | Other property. |
| Total | $59, 682, 154 | 564, 700 | 46, 802 | 517, 898 | $12, 795, 715 | $7, 472, 157 | $31, 637, 284 | $7, 776, 998 |
| Pennsylvania | 34, 398, 832 | 277, 430 | 25, 411 | 252, 019 | 7, 589, 968 | 3, 757, 961 | 18, 955, 018 | 4, 095, 885 |
| Indiana | 8, 205, 813 | 77, 493 | 12, 294 | 65, 199 | 1, 090, 218 | 1, 396, 949 | 4, 792, 548 | 926, 098 |
| Ohio | 12, 953, 750 | 112, 252 | 3, 712 | 108, 540 | 3, 241, 679 | 1, 702, 051 | 6, 418, 342 | 1, 591, 678 |
| New York | 1, 162, 429 | 49, 870 | 533 | 49, 337 | 298, 120 | 169, 753 | 580, 519 | 114, 037 |
| Missouri | 313, 300 | 15 | 5 | 10 | 176, 800 | 90, 800 | 44, 200 | 1, 500 |
| Kansas | 160, 000 | 2, 002 | 2 | 2, 000 | 10, 200 | 22, 500 | 27, 200 | 100, 100 |
| California | 51, 750 | 6 | 6 | | 1, 900 | 49, 635 | 215 | |
| Illinois | 45, 220 | 19, 044 | 44 | 19, 000 | 3, 200 | 23, 620 | 18, 400 | |
| Kentucky | 2, 146, 400 | 23, 215 | 3, 800 | 19, 415 | 275, 550 | 128, 950 | 800, 700 | 941, 200 |
| West Virginia | 114, 700 | 218 | | 218 | 11, 280 | 103, 395 | 25 | |
| Texas | 80, 000 | 725 | 725 | | 72, 500 | 1, 500 | | 6, 000 |
| Arkansas | 24, 000 | 2, 000 | | 2, 000 | 20, 000 | 3, 500 | | 500 |
| Utah | 3, 000 | | | | | 2, 970 | 30 | |
| South Dakota | 1, 360 | | | | | 1, 273 | 87 | |
| New Mexico | 3, 000 | | | | | 3, 000 | | |
| Tennessee | 14, 500 | 270 | 270 | | 2, 700 | 11, 800 | | |
| Wisconsin | 4, 100 | 160 | | 160 | 1, 600 | 2, 500 | | |

## LABOR AND WAGES IN THE PRODUCTION OF NATURAL GAS IN THE UNITED STATES IN 1889.

The total number of persons employed in the production of natural gas in the United States in 1889 is given as 6,684, to whom $1,736,389 were paid in wages. Of the total number of employés, 374 were foremen or overseers, 889 mechanics, 5,004 laborers, 6 boys under 16 years, 395 males engaged in office work, and 16 females engaged in office work. It must be understood that these workmen were employed not only in the production of gas, but in its distribution. This report is by no means satisfactory, and is to a large extent meaningless, or at least the terms used are such as to lead to confusion in the classification. A better classification is given in the second table below, which shows more in detail the number of persons employed and by more definite occupations.

LABOR AND WAGES.

| STATES AND TERRITORIES. | TOTAL. | | FOREMEN OR OVERSEERS. | | MECHANICS. | | LABORERS. | | BOYS UNDER 16 YEARS. | | OFFICE. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Males. | | Females. | |
| | Number. | Wages. | Number. | Wages. | Number. | Wages. | Number. | Wages. | Number. | Wages. | Number. | Wages. | Number. | Wages. |
| Total | 6, 684 | $1, 736, 389 | 374 | $235, 553 | 889 | $357, 840 | 5, 004 | $851, 945 | 6 | $648 | 395 | $285, 439 | 16 | $4, 964 |
| Pennsylvania | 3, 282 | 1, 092, 709 | 145 | 126, 424 | 399 | 207, 210 | 2, 529 | 571, 445 | 1 | 50 | 202 | 185, 567 | 6 | 2, 013 |
| Indiana | 2, 007 | 341, 851 | 153 | 58, 865 | 324 | 97, 091 | 1, 408 | 134, 388 | 2 | 160 | 115 | 49, 287 | 5 | 2, 060 |
| Ohio | 983 | 241, 218 | 59 | 40, 702 | 97 | 32, 997 | 757 | 125, 938 | 3 | 438 | 63 | 40, 337 | 4 | 806 |
| New York | 357 | 34, 235 | 11 | 4, 152 | 37 | 4, 443 | 296 | 17, 687 | | | 12 | 7, 868 | 1 | 85 |
| Missouri | 2 | 85 | | | 1 | 50 | 1 | 35 | | | | | | |
| Kansas | 3 | 2, 100 | | | 1 | 900 | 1 | 200 | | | 1 | 1, 000 | | |
| Illinois | 5 | 1, 222 | 1 | 750 | | | 3 | 172 | | | 1 | 300 | | |
| Kentucky | 21 | 13, 016 | 3 | 3, 360 | 14 | 8, 056 | 3 | 520 | | | 1 | 1, 080 | | |
| West Virginia | 6 | 1, 800 | | | 6 | 1, 800 | | | | | | | | |
| Texas | 3 | 1, 980 | 1 | 900 | 1 | 720 | 1 | 360 | | | | | | |
| Arkansas | 4 | 2, 500 | | | 4 | 2, 500 | | | | | | | | |
| South Dakota | 1 | 73 | | | 1 | 73 | | | | | | | | |
| New Mexico | 4 | 2, 000 | | | 4 | 2, 000 | | | | | | | | |
| Wisconsin | 6 | 1, 600 | 1 | 400 | | | 5 | 1. 200 | | | | | | |

Of the $1,736,389 paid for wages in 1889, $235,553 was paid to foremen or overseers, $357,840 to mechanics, $851,945 to laborers, $648 to boys under 16 years, $285,439 to office force, males, and $4,964 to office force, females. In addition to these wages a large amount of money was paid to contractors for drilling wells, laying pipe lines, etc., into which labor entered largely. Of wages so paid no account is given.

In the following table will be found totals showing the occupation and number of employés of each kind in the United States:

| CLASS OF LABOR. | Total. | Pennsylvania. | Indiana. | Ohio. | New York. | Missouri. | Kansas. | Illinois. | Kentucky. | West Virginia. | Texas. | Arkansas. | South Dakota. | New Mexico. | Wisconsin. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 6, 684 | 3, 282 | 2, 007 | 983 | 357 | 2 | 3 | 5 | 21 | 6 | 3 | 4 | 1 | 4 | 6 |
| Presidents | 1 | 1 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Treasurers | 2 | 1 | 1 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Bookkeepers | 132 | 36 | 80 | 9 | 7 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Clerks, males | 248 | 160 | 41 | 40 | 4 | ........ | 1 | 1 | 1 | ........ | ........ | ........ | ........ | ........ | ........ |
| Clerks, females | 22 | 4 | ........ | 17 | 1 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Telegraph operators | 10 | 6 | ........ | 1 | 3 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Superintendents | 54 | 13 | 29 | 7 | 5 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Foremen or overseers | 311 | 130 | 121 | 44 | 10 | ........ | ........ | 1 | 3 | ........ | 1 | ........ | ........ | ........ | 1 |
| Electricians | 9 | 1 | ........ | 8 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Inspectors | 39 | 34 | 5 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Station agents | 35 | 25 | 10 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Agents | 1 | ........ | ........ | ........ | 1 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Engineers | 10 | 2 | 6 | ........ | 2 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Fitters or plumbers | 318 | 146 | 160 | 12 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Drillers | 146 | 61 | 38 | 32 | 10 | ........ | 1 | ........ | ........ | 4 | ........ | ........ | ........ | ........ | ........ |
| Tool dressers | 34 | 22 | ........ | 12 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Carpenters | 28 | 21 | 5 | ........ | ........ | ........ | ........ | ........ | ........ | 2 | ........ | ........ | ........ | ........ | ........ |
| Fieldmen or wellmen | 61 | 52 | ........ | 6 | 3 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Teamsters | 42 | 19 | 10 | ........ | 13 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Linemen | 59 | 23 | 33 | ........ | 3 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Warehousemen | 2 | 2 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Blacksmiths | 2 | 2 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Tongsmen | 69 | 69 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Watchmen | 12 | 7 | ........ | ........ | 5 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |
| Mechanics | 340 | 153 | 92 | 37 | 33 | 1 | ........ | ........ | 14 | ........ | 1 | 4 | 1 | 4 | ........ |
| Laborers | 4, 691 | 2, 291 | 1, 374 | 755 | 257 | 1 | 1 | 3 | 3 | ........ | 1 | ........ | ........ | ........ | 5 |
| Boys under 16 years | 6 | 1 | 2 | 3 | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ | ........ |

## TOTAL EXPENDITURE FOR MATERIALS DURING 1889.

The total expenditure during 1889 for all materials used in drilling wells, operating and caring for the same, building pipe lines, and for all other materials, was $13,184,497. Of this amount $165,677 was paid for materials used in building rigs, $467,540 for materials used in drilling wells, $282,882 for materials used in operating, shutting in, and caring for wells, $7,044,438 for pipe lines, $285,180 for materials used in fitting, $28,794 for torpedoes, and $4,915,086 for all other materials. Considerable work was done by contract, including labor and materials. It was impossible to make a division of the amounts between labor, materials, etc.

TOTAL EXPENDITURES FOR MATERIALS DURING 1889.

| STATES. | Total. | Building rigs. | Drilling wells. | Operating, shutting in, and caring for wells. | Pipe, couplings, etc., in building and repairing pipe lines. | Used in fitting. | TORPEDOES. |  | All other materials. |
|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  | Number. | Value. |  |
| Total | $13, 184, 497 | $165, 677 | $467, 540 | $282, 882 | $7, 044, 438 | $285, 180 | 281 | $28, 794 | $4, 915, 086 |
| Pennsylvania | 4, 963, 780 | 113, 022 | 326, 674 | 188, 550 | 855, 192 | 227, 926 | 55 | 6, 167 | 3, 246, 249 |
| Indiana | 1, 921, 072 | 3, 800 | 42, 710 | 38, 712 | 1, 761, 203 | 40, 190 | 82 | 10, 275 | 24, 182 |
| Ohio | 5, 722, 865 | 26, 019 | 66, 751 | 44, 710 | 4, 261, 054 | 970 | 86 | 8, 228 | 1, 315, 133 |
| New York | 511, 141 | 17, 336 | 22, 405 | 5, 810 | 131, 144 | 16, 094 | 41 | 2, 330 | 316, 022 |
| Missouri | 14, 200 | 500 | .......... | .......... | 12, 200 | .......... | .......... | .......... | 1, 500 |
| Kansas | 14, 705 | 4, 500 | 6, 500 | 1, 800 | 1, 555 | .......... | 2 | 350 | .......... |
| California | 90 | .......... | .......... | .......... | 90 | .......... | .......... | .......... | .......... |
| Illinois | 17, 600 | .......... | .......... | 1, 600 | 16, 000 | .......... | .......... | .......... | .......... |
| Kentucky | 15, 644 | 500 | .......... | 1, 700 | 6, 000 | .......... | 15 | 1, 444 | 6, 000 |
| Wisconsin | 3, 400 | .......... | *a*2, 500 | .......... | .......... | .......... | .......... | .......... | 900 |

*a* Includes cost of rigs, drive pipes, casing, and tubing.

## PIPE LINES.

The total number of feet of pipe line used in the distribution of natural gas in the United States at the close of 1888 was 25,564,594, and at the close of 1889 was 37,746,093, divided into sizes as follows:

TOTAL NUMBER OF FEET OF PIPE LINE USED IN THE DISTRIBUTION OF NATURAL GAS IN THE UNITED STATES AT THE CLOSE OF 1888 AND 1889.

| SIZES (inches). | 1888. | 1889. |
|---|---|---|
| Total | 25, 564, 594 | 37, 746, 093 |
| ⅜ | 2, 201 | 3, 341 |
| ½ | 907 | 7, 135 |
| ¾ | 423, 764 | 886, 925 |
| 1 | 1, 157, 774 | 3, 039, 912 |
| 1¼ | 324, 938 | 730, 454 |
| 1½ | 632, 774 | 840, 226 |
| 2 | 4, 987, 328 | 7, 222, 308 |
| 2½ | 52, 360 | 53, 780 |
| 3 | 3, 052, 615 | 4, 213, 230 |
| 3¼<br>3½ | 8, 422 | 8, 422 |
| 4 | 3, 165, 590 | 4, 913, 883 |
| 5 | 294, 127 | 308, 434 |
| 5⅝ | 184, 800 | 233, 106 |
| 6 | 3, 308, 077 | 3, 866, 192 |
| 8 | 5, 167, 462 | 6, 979, 459 |
| 9<br>10 | 1, 405, 120 | 2, 141, 368 |
| 12 | 642, 900 | 1, 369, 613 |
| 14 | 643 | 643 |
| 16 | 369, 252 | 480, 693 |
| 20 | 193, 780 | 205, 942 |
| 24 | 106, 669 | 148, 056 |
| 30<br>36 | 83, 091 | 92, 971 |

The tendency is toward the use of larger pipes, as these will transport more gas with less loss by friction than smaller pipes.

## NATURAL GAS IN PENNSYLVANIA.

The following statement regarding natural gas and petroleum in Pennsylvania has been prepared for this report by Mr. John F. Carll, to whom special acknowledgment is due.

All the petroliferous rocks thus far profitably developed in western Pennsylvania and the contiguous portions of New York and West Virginia are found in sediments of devonian and carboniferous age; hence in discussing the various prolific horizons it is only necessary to consider that part of the geologic column which overlies the silurian system. The chart of these upper paleozoic rocks now generally accepted is as follows:

TABLE OF THE PALEOZOIC ROCKS.

| NUMBER. | |
|---|---|
| XVII. | Greene county series: From surface to top Washington upper limestone. |
| XVI. | Washington county series: From top Washington upper limestone to top Waynesburg sandstone. |
| XV. | Monongahela series: From top Waynesburg sandstone to base Pittsburg coal. |
| XIV. | Pittsburg series: From base Pittsburg coal to base Mahoning sandstone. |
| XIII. | Allegheny series: From base Mahoning sandstone to top Homewood sandstone. |
| XII. | Pottsville series: From top Homewood sandstone to base Olean conglomerate. |
| XI. | Mauch Chunk: From base Olean conglomerate to top subolean conglomerate. |
| X. | Pocono series: From top subolean to top of Venango-Butler oil group. |
| IX. | Catskill series: Venango-Butler oil group. |
| VIII. | Chemung,<br>Portage,<br>Genesee,<br>Tully limestone,<br>Hamilton,<br>Marcellus,<br>Upper Helderberg. } From base of Venango-Butler oil group to top of Oriskany sandstone. |
| VII. | Oriskany sandstone. |

Formations Nos. XVII, XVI, and XV, all lying above the Pittsburg coal bed, are found only in the southwestern part of the state. Their aggregate thickness near the West Virginia line is about 1,600 feet; north of the Ohio and

Allegheny at Pittsburg they are reduced to nothing by erosion, as only a few patches of Pittsburg coal remain in high, isolated knobs. None of these rocks have ever produced oil or gas in paying quantities in Pennsylvania.

No. XIV, 550 to 600 feet in thickness, has a more extended range than the above. The crinoidal limestone and its accompanying red shale lie near the center of the group and come to the surface in northern Allegheny and southern Armstrong. Its bottom member, the Mahoning sandstone, holds its place among the country rocks as far north as Red Bank creek. This sandstone has produced some oil in the Dunkard creek region of Greene county and near Pleasant Unity in Westmoreland county, but it can not be rated as a very profitable oil-bearing rock.

No. XIII, thickness about 300 feet, carries the valuable Freeport, Kittanning, Clarion, and Brookville coals and the ferriferous limestone, but produces neither oil nor gas.

No. XII, the Pottsville series, is in western Pennsylvania, a composite formation from 250 to 350 feet in thickness, consisting of 3 sandstones, separated by beds of shale carrying the Mercer and Sharon coal seams and limestones. Various geographical names are used in designating these sandstones: for the uppermost, Homewood sandstone, Johnson Run sandstone; for the middle, Connoquenessing sandstone, Kinzua creek sandstone; for the basal, Sharon-Olean-Ohio conglomerate. This group, well defined and persistent all across the western end of the state, lies at the base of the productive coal measures, and probably represents the millstone grit of England. The Pottsville series is not under sufficient cover nor deep enough below river drainage in the northern counties to fit it for oil production; but on Slippery Rock, in Lawrence county, and at Smiths Ferry, in Beaver county, some heavy oil has been obtained apparently from its bottom member. In Washington county it sometimes produces both oil and gas. One of the most remarkably prolific wells of that section, the Manifold well, yielded a light-gravity oil from the Homewood sandstone. It is also productive in many localities in West Virginia and Ohio. As an oil-bearing group, however, even under ample cover, it is pockety, unreliable, and deceptive, permanently rewarding few of the operators who engage in its development.

The Olean conglomerate, a massive pebbly stratum measuring from 40 to 70 feet in thickness, lies completely uncovered along its northerly outcrop upon the highlands near the Pennsylvania-New York state line at an elevation of 2,340 feet above ocean level. North of this range every vestige of it has been removed by erosion, but towards the south it plunges under cover, dipping at an average rate of about 19 feet to the mile. In central McKean it has taken on its back the upper members of No. XII; near Bradys Bend it disappears beneath the waters of the Allegheny, bearing all the rocks of No. XIII above it; at Pittsburg it is found 850 feet below the river level—150 feet below tide and 2,490 feet below its northerly outcrop. Here, beneath the highlands, it carries above it Nos. XIII and XIV and part of No. XV. Continuing onward to the southwestern portion of Greene county, its dip is more variable, being affected by the anticlinal waves which trend across that part of the state, but it gradually sinks and increases its cover until all the rocks of Nos. XV, XVI, and XVII have been added to its load, burying it in some places more than 2,400 feet beneath the surface.

Since the sediments along the range of the oil belt were deposited layer upon layer in conformable sequence, and subsequently elevated bodily to their present inclined position by the Appalachian uplift without any serious stratigraphical disturbance, it follows that the dip of this Olean-Sharon conglomerate represents approximately the dip of all its associated rocks, both above and below it. Hence, if an oil well at Bradford commencing at the base of the Olean conglomerate requires to be sunk 1,850 feet to reach the Bradford oil sand, one to reach the same horizon anywhere at the southwest must go 1,850 feet plus whatever thickness of cover may be above the conglomerate. This is a broad theoretical calculation, however, which can not always be depended upon except within certain bounds and along lines running in the proper direction; but it serves to show why the oil wells in the southwestern field require to be so much deeper than those in the northeastern.

No. XI (Mauch Chunk red shale, or mountain limestone) seldom exceeds 50 feet in thickness along its northerly outcrop in McKean, Warren, and Crawford counties, where it is generally a bed of sandy shale; but in the latitude of central Butler the mountain limestone makes its appearance, and farther south the characteristic red bands of this division come in, gradually expanding its dimensions to about 180 feet in Greene county and 200 or more in West Virginia. In Pennsylvania the oil and gas indications in this group are of no commercial importance, but in West Virginia and Kentucky the indications appear more promising.

No. X, the Pocono series, is very variable both in composition and thickness. Along the Pennsylvania oil belt it measures from 400 to 500 feet in thickness, but in Huntingdon county swells to over 2,100 feet. As the series is traced southward the dividing line between Nos. X and XI becomes somewhat indistinct, the deposits occupying the horizon of juncture being of such a character that it is difficult to say where one group ends and the other commences. In Venango and Crawford counties it is principally a mass of shale, carrying the Shenango sandstone at its top and the Berea grit near its center. Bordering the Pennsylvania-Ohio line a similar structure prevails, but in southern Butler, Allegheny, and Westmoreland counties another well-defined sandstone, the Butler gas sand, makes its appearance near the bottom of the series, and when this sand is fully developed the Berea grit appears to be absent.

Three oil and gas bearing horizons are to be credited to this series, to wit: (1) Shenango sandstone, (2) Berea grit, (3) Butler gas sand.

(1) The Shenango sandstone, in common with all the oil-producing strata, has had different names applied to it in

different localities. Along its northerly outcrops, where it is well exposed and seldom more than 40 feet in thickness, it is called the subolean conglomerate in the counties of McKean and Crawford, and Shenango sandstone in the counties of Crawford and Mercer. Thickening as it goes southwestward, it becomes the drillers' Big Injun in the Greene county and West Virginia oil field, the Logan sandstone of the Ohio reports, and the salt-water rock of the Macksburg oil region. North of Pittsburg, though pierced by thousands of wells, it has never given any promising indications. In Washington county sporadic but unimportant deposits of both oil and gas have been found, and in Fayette county a gas field of sufficient pressure and volume was developed in 1887 to warrant piping the gas to Uniontown, where it is still being utilized.

The first great and really prolific pool of oil and gas in this Big Injun sand was discovered by Mr. E. M. Hukill while vigorously prospecting in the Dunkard creek region for the Washington county oil sands. His Mount Morris well No. 1 was struck in October, 1886; but it was nearly a year later before active work commenced in the new field. A number of large oil wells and several powerful gas wells have since been obtained, and the belt or pool extends toward the southwest several miles across the state line into West Virginia. How far it may continue and what grade this rock is destined to take among the celebrated oil horizons of the country remains to be demonstrated by future developments; but with the untested wilds of West Virginia spreading out at the southwest it would not be surprising if the field should eventually be greatly extended and rank with the best at the north. A pipe line has already been laid for transporting the oil to market, and the average run for the month of December, 1888, was 729 barrels per day.

(2) The Berea grit is of little importance as an oil bearer in the state of Pennsylvania, having been productive only in a few limited areas in Mercer, Lawrence, and Beaver counties. In Ohio, however, it furnishes heavy oil at Mecca, Grafton, etc., and light oil at Macksburg and other localities near the Ohio river. It is there also, where found under sufficient cover, the repository of valuable deposits of natural gas.

(3) The Butler gas sand has its best development in southern Butler, Allegheny, and the eastern part of Westmoreland counties. It lies from 40 to 80 feet above the First sand of the Venango-Butler oil group, and varies in thicknesss from 30 to 60 feet. Whether it is an independent sand bed or only the easterly representative of the Berea grit is not yet positively known, as no line of closely-connected sections of oil-well borings between the Berea grit region of Ohio and the Butler oil belt have been published. As far as known the Berea grit is never positively identifiable in its theoretical horizon in any well where the Butler gas sand is normally developed. Hence, it is quite possible that the Butler gas sand and the Berea grit are identical, the sand bed having been deposited over the southern part of the Butler belt at a lower level than elsewhere in Pennsylvania and Ohio. This sand, as its name indicates, is almost exclusively a gas-bearing sand.

No. IX, Catskill. This series holds the world-renowned First, Second, Stray, and Third sands of Oil creek, now called the Venango-Butler oil group, whose combined production from the striking of the first well in August, 1859, to January 1, 1890, aggregates about 128,000,000 barrels. Speaking in general terms, the group in a productive form (but not persistently productive throughout its whole extent) reaches from Tidioute, in Warren county, to Waynesburg, in Greene county, being about 130 miles in length, and, say, from 10 to 20 miles in width. Between these points no oil has been produced along the trend of the belt from any of the underlying strata, although many wells have been drilled from 200 to 2,000 feet below the Third sand, and only an inconsiderable quantity has been obtained from the overlying rocks, as mentioned above. Neither has any commercial gas been discovered in the older rocks, except in the Speechley gas field of Venango county, where the southeasterly extension of one of the Chemung oil sands of Warren county is overlapped by the Venango group. Northeast of a line drawn from the northwest corner of Warren county to the northwest corner of Clearfield county the Catskill rocks are so altered in composition and stratigraphical arrangement that they are unproductive, and in addition to this the prevailing northerly slope carries them into the hilltops before reaching the state line. Southwest of Waynesburg the rocks have not been very thoroughly exploited, owing to the deep, hazardous, and expensive drilling; but the developments thus far made indicate unfavorable changes in the composition and structure, which seem to give notice that the southerly end of the productive belt is near. This group has a thickness of about 300 feet in Warren county, 360 in Butler county, 450 at the Ohio River, and 500 feet in Washington county, and going in a transverse direction it thickens toward the east, swelling to 700 feet in the Murrysville and Grapeville gas fields of Westmoreland county, and thence rapidly increasing to 2,500 in Blair county and 5,000 feet in Carbon county.

The sandstones of this group, like all other sandstones, are subject to variations in thickness, composition, and methods of stratification. In one place 3 well-defined sand beds may appear, in another 5 or 6; still the 6 sands are always found within exactly the same geological horizon as the 3; but drillers, not understanding this fact, have invented new names or misapplied old ones as they moved from field to field until the original simplicity of nomenclature adopted on Oil creek has been entirely lost sight of. It so happened that the first wells on Oil creek commenced to drill below the Berea grit, which is completely cut through by the stream and escarps plainly above water level all the way from Titusville to Oil City; consequently the first massive sandstone encountered was the top member of the oil group. This the pioneers very naturally called First sand. Finding another about 140 feet from the top of the First, and still another about 140 feet deeper containing abundant supplies of oil and gas, they counted these Second and Third. Before reaching the productive rock (say, 30 feet above it) an impure gray sand was passed through, which was at first considered as an accidental or "stray" sand, out of place and unworthy of notice. It was not long, however, before this stratum was found in some of the wells improved in constitution and largely productive, and thenceforward it became one of the regular members of the group under the name of "stray sand". These 4 sandstones, with their included shale beds, are the sole constituents of the Venango-Butler oil group, in which have been found all the noted oil and gas pools of the country, from Warren county to Greene. There are no other members on Oil creek where it has its typical normal development, and it takes in no new ones in its extension southward. Of course the group varies locally in thickness, in the number of its sand beds, and in special details of structure, but its top and bottom planes are always well defined, and whatever confusing and misleading names may be applied to individual productive horizons they all fall, when properly correlated, within these lines.

The sand beds lying in the horizon of the regular First sand have been variously called in different districts as follows:

First sand horizon: Quinn sand, Amber oil sand, Franklin lubricating oil sand, Second, Fifty-foot, Hundred-foot, Salt-water rock, Gantz, Murrysville gas sand, Grapeville gas sand.

Second sand horizon: Lytle sand, Amber oil sand, Salt-water sand, Stray Third, Third, Fourth, Thirty-foot, Blue Monday, Bowlder, Hickory, Gordon, Pine Run.

Stray sand horizon: Gray Rock, Bowlder, Blue Monday, Hickory, Clover seed, Black oil sand, Second, Third, Fourth.

Third sand horizon: Gordon, Weister, Hickory, Green oil sand, Fourth, Fifth, Sixth.

Many other names have been used, but these are sufficient to show how utterly impossible it is for one to satisfactorily locate an oil or gas bearing horizon if he has nothing but the popular local names to guide him. The terms Fourth, Fifth, and Sixth are particularly misleading, since they carry the inference that these sands lie below the regular Third sand and add 3 productive members to the group, which is clearly not the case.

No. VIII. This series as numbered in Pennsylvania includes 7 divisions of the geological chart of New York, its cover being the Catskill group, its base the Oriskany sandstone. The corniferous limestone, one of its basal members—

> Outcrops at Black Rock, New York, forming a slight barrier and a small island in the outlet of Lake Erie. From this point it can be traced eastward as far as Cayuga lake, and westward to the Enniskillen oil fields of Canada. Dipping at the rate of 25 feet to the mile, it plunges under the oil regions of western Pennsylvania to a depth of more than 5,000 feet, and then rises to daylight along the easterly slope of the Cincinnati uplift in eastern Ohio. Superimposed upon this limestone lies the Erie division of the New York reports, which, in ascending order, is composed of the Marcellus slates or shales, characteristically black and pyritous, the Hamilton group of gray shales and limestones, the Genesee slates, black and similar in appearance to the Marcellus, and the Portage and Chemung groups. These deposits bring us up to the base of the Venango-Butler group.

The total thickness of the series, as measured in the Wheatland well, near West Middlesex, Mercer county, is 2,635 feet, and in the Conway well, 9 miles south of Franklin, Venango county, 3,275 feet. The first is but a short distance from the Ohio line, the last is on the Venango oil belt. These wells, commencing, of course, above the Catskill rocks, were respectively 3,484 and 3,880 feet deep. The Westinghouse well at Pittsburg failed to reach the corniferous limestone, although it was sunk to a depth of 4,618 feet.

The several oil and gas sands of the counties of McKean, Warren, Forest, and Elk lie in the Chemung division of No. VIII, and no commercial oil or gas has been found in Pennsylvania in any of the deeper rocks. Only 3 or 4 wells are known to have reached the corniferous limestone, but these are sufficient to show that, on account of its great depth and variable composition, it is, to say the least, a very unpromising stratum to drill for.

> In Warren and Forest the upper part of the Portage-Chemung incloses several well-defined and massive layers of white or gray oil-bearing sandstones, the first lying about 300 feet from its top, the last about 1,200 feet. These are known in descending order as the oil sands of Warren, Clarendon, Cherry Grove, and Cooper; and they lie embedded in typical Chemung slates which also extend below the Cooper sand as far as the drill has pierced. Some of the productive pools of this group lie not more than 10 miles east of productive pools in the Venango group, but the sands of the former thin out and disappear in this interval, so that hardly a trace of them can be found in the deep wells sunk through the latter.
>
> To the southwest, however, one of these deep sands can be traced across Forest and Venango for about 30 miles, and in eastern Venango, under the name of "Speechley sand", is largely productive of gas, but so far barren of oil. This gas rock underlies the middle ground between the Venango and the Clarion belts, where the Venango group is imperfectly developed.
>
> The McKean group: Stretching out toward the northeast, the Warren sands extend into the Bradford district, and no doubt some of them could be identified with the upper sands of the Bradford or McKean group if drillers would take the trouble to keep a few reliable records in this region; but they will not do this, and we must be content with the above qualified statement, as it is impossible under the present circumstances to systematically trace any particular stratum from one district to the other.
>
> Elk group: Along the southeasterly edge of the Bradford field, and also of Warren and Forest, 2 or 3 other brown sands are found beneath the horizon of the Bradford sand, the lowest one lying about 1,700 feet below the top of the Chemung formation. These sands are found at Startwell, Smethport, Wilcox, Kane, and in Elk county. They appear to be meagerly developed beneath the Bradford and Warren-Forest groups to the northwest, and, per contra, the sands of the last-named group are poorly developed or entirely wanting along the range of the Elk group. It is to be remembered also that the Bradford oil sand is limited approximately in its western extension to a northeast-southwest line projected through the Cooper field of Warren county, where a brown sand somewhat similar to the Bradford oil rock, and which is sometimes productive, immediately overlies the white or gray Cooper sand.

Reviewing what is said above, it is seen that all along the Venango-Butler oil belt, from Tidioute southwestward, the Portage-Chemung is simply a homogeneous mass of slates or slaty shales with no sandy layers worthy of note; that under the Warren and Forest district it contains in its upper 1,200 feet several beds of coarse white or gray oil sands, the first one lying about 300 feet below the top of the mass, this 300 feet, the intervals between the sandstones and the measures below the Cooper sand, as far as the drill has gone, being occupied by grayish slates or shales, with some bands of red similar to those underlying the Venango belt; that under the Bradford district, to a depth of about 1,300 feet (and Allegany, New York, may be included here), similar conditions to those of Warren and Forest exist, except that the most productive sands of Bradford are brownish black instead of white or gray; that in Potter, southeastern McKean, and Elk other brown sands are found to the depth of about 400 feet below the horizon of the Bradford sand, and that in these fields, as in the pools along the Venango belt, the productive portion of one range never, as a general rule, overlaps the productive portion of another.

The oil and gas producing horizons of Pennsylvania come in geological sequence as follows:

| | |
|---|---|
| No. XIV. | Mahoning sandstone. |
| No. XIII. | Barren. |
| No. XII. | Homewood sandstone.<br>Olean conglomerate. |
| No. XI. | Barren. |
| No. X. | Big Injun.<br>Berea grit.<br>Butler gas sand. |
| No. IX. | First sand and its divisions.<br>Second sand and its divisions.<br>Stray sand and its divisions.<br>Third sand and its divisions. |
| No. VIII. | North Warren and Bradford "slush oil".<br>Warren sand.<br>Clarendon sand.<br>Cherry Grove—Balltown sand.<br>Cooper sand.<br>Bradford "Third sand".<br>Wilcox lower gas sands.<br>Kane sand.<br>Elk county sands, extending to a depth of about 1,700 feet beneath group No. IX. |

As far as known at present the interval between the Elk county sands and No. VII is barren.

Of the Silurian rocks nothing is known from practical well drilling in western Pennsylvania except in one locality. In the city of Erie the Presque Isle well was successfully bored down to the Trenton limestone, the great oil and gas producing rock of Lima and Findlay, Ohio, but no encouraging indications of either oil or gas were developed. The Trenton rock contained nothing but salt water. It was struck at 4,310 feet from the surface, or 3,710 feet below ocean level. At 1,325 feet the corniferous limestone was found, hence from its top to the Trenton there is an accurately measured interval of 2,985 feet. From this it would seem probable that the Trenton limestone could not be reached at Pittsburg at a depth of less than 8,000 feet, and possibly the overlying shales may thicken in that direction and make the depth considerably greater.

### PRODUCTION.

The total value of natural gas produced in Pennsylvania in 1889, as shown in the first table on the following page, measured by the amount received for it, was $8,287,383. The amount of coal displaced by this natural gas was 6,863,062 tons, the value of this coal being estimated at $11,593,989. In addition to this, much the larger proportion of the 500,000 tons of coal estimated as having been used in drilling oil and other gas wells and in the pumping of oil, both in pipe lines and at the wells, was consumed in Pennsylvania. This table shows some facts that require explanation. The largest amount of coal displaced credited to any one county is to Westmoreland, 4,039,222 tons being displaced by the gas from this county, while but 90,500 tons are reported as displaced by the gas produced in Allegheny county, though Allegheny county, in which is Pittsburg, consumed many times more natural gas than any other county in the United States. The explanation of this is that most of the gas consumed in Allegheny county comes from Westmoreland and Washington counties. It will be noticed that the amount and value of coal displaced by gas in Westmoreland county is very little more than the amount received for the gas. In other words, the producers of natural gas in these counties receive for the gas very nearly the value of the coal displaced by it.

PRODUCTION OF NATURAL GAS IN PENNSYLVANIA IN 1889, BY COUNTIES.

| COUNTIES. | Value of natural gas supplied and used. | COAL DISPLACED. | |
|---|---|---|---|
| | | Tons. | Value. |
| Total | $8, 287, 383 | 6, 863, 062 | $11, 593, 989 |
| Allegheny | 178, 127 | 90, 500 | 213, 200 |
| Armstrong | 6, 500 | 4, 853 | 7, 280 |
| Beaver | 198, 646 | 136, 761 | 223, 405 |
| Butler | 299, 692 | 151, 350 | 390, 909 |
| Cambria | 3, 240 | 3, 350 | 5, 000 |
| Clarion | 30, 455 | 13, 338 | 31, 407 |
| Elk | 380, 932 | 313, 230 | 306, 665 |
| Erie | 15, 192 | 6, 047 | 19, 926 |
| Fayette | 62, 500 | 60, 869 | 70, 000 |
| Forest | 32, 769 | 21, 420 | 57, 900 |
| Greene | 797 | 350 | 800 |
| Indiana | 14, 690 | 10, 000 | 20, 000 |
| Jefferson | 4, 720 | 1, 710 | 5, 220 |
| McKean | 1, 220, 116 | 622, 628 | 2, 401, 668 |
| Mercer | 13, 000 | 6, 000 | 13, 000 |
| Potter | 20, 468 | 15, 601 | 63, 387 |
| Venango | 866, 485 | 996, 410 | 2, 506, 450 |
| Warren | 18, 000 | 13, 350 | 20, 000 |
| Washington | 471, 520 | 356, 073 | 688, 992 |
| Westmoreland | 4, 449, 534 | 4, 039, 222 | 4. 548, 780 |

In the following table will be found a statement of the uses to which the natural gas produced in Pennsylvania in 1889 was put:

USES TO WHICH NATURAL GAS PRODUCED IN PENNSYLVANIA IN 1889 WAS PUT.

| COUNTIES. | Fires for cooking and heating. | Iron rolling mills. | Steel works. | Glass works. | Gas companies. | Other industrial establishments. |
|---|---|---|---|---|---|---|
| Total | 280, 484 | 58 | 15 | 69 | 8 | 1, 604 |
| Allegheny | 6, 704 | 4 | | 1 | 1 | 21 |
| Armstrong | 819 | | | | | 4 |
| Beaver | 6, 746 | 3 | | | | 7 |
| Butler | 3, 725 | | | 6 | | 14 |
| Cambria | 123 | | | | | |
| Clarion | 1, 855 | | | | 1 | 48 |
| Elk | 2, 150 | | | | | 12 |
| Erie | 584 | | | | | 1 |
| Fayette | 3, 500 | | | 2 | | |
| Forest | 1, 805 | | | | | 26 |
| Greene | | | | | | 3 |
| Indiana | 500 | | | | | 2 |
| Jefferson | 352 | | | | | |
| McKean | 28, 999 | | | | 6 | 71 |
| Mercer | 500 | | | | | 1 |
| Potter | 88 | | | | | 25 |
| Venango | 17, 317 | 1 | 1 | 3 | | 291 |
| Warren | 500 | | | | | 4 |
| Washington | 15, 070 | 6 | 2 | 17 | | 264 |
| Westmoreland | 189, 147 | 44 | 12 | 40 | | 810 |

This table shows that 280,484 fires used gas in Pennsylvania for heating and cooking in 1889; also 58 iron rolling mills, 15 steel works, 69 glass works, 8 gas companies, and 1,604 other industrial establishments. Of the fires for heating and cooking 189,147 were supplied with gas from wells in Westmoreland county, as well as 44 of the 58 rolling mills, 12 of the 15 steel works, 40 of the 69 glass works, and 810 of the 1,604 other industrial establishments.

## WELLS.

The number of wells producing natural gas in Pennsylvania at the close of 1889 was 999, and 810 at the close of 1888, making an increase during the year 1889 of 189 wells. The number of wells reported as abandoned during the year 1889 was 47. Of 239 wells completed during the year 207 were producing and 32 dry holes.

The total cost of drilling these wells, including drive pipe, casing, etc., was $683,709, of which $208,454 was expended for labor and $231,824 for materials, making a total of $440,278, the remaining $243,431 having been paid for contract work.

### WELL RECORD, BY COUNTIES.

| COUNTIES. | DRILLING WELLS. | | WELLS COMPLETED IN 1889. | | | NUMBER WELLS PRODUCING. | | Number abandoned in 1889. | Total cost of drilling wells, including drive pipe, casing, etc. | DETAIL OF COST. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | December 31, 1888. | December 31, 1889. | Total. | Producing. | Dry holes. | December 31, 1888. | December 31, 1889. | | | Labor. | Material. |
| Total | 18 | 31 | 239 | 207 | 32 | 810 | 999 | 47 | $683,709 | $208,454 | $231,824 |
| Allegheny | 1 | ........ | 7 | 5 | 2 | 27 | 35 | 7 | 26,426 | 4,990 | 4,010 |
| Armstrong | ........ | ........ | 2 | 2 | ........ | 3 | 5 | ........ | 8,000 | (a) | ........ |
| Beaver | ........ | ........ | ........ | ........ | ........ | 82 | 70 | 12 | 22,704 | 16,104 | 6,600 |
| Butler | ........ | 3 | 29 | 22 | 7 | 50 | 70 | 6 | 64,192 | 4,451 | 5,768 |
| Cambria | ........ | ........ | 1 | 1 | ........ | 4 | 5 | ........ | 5,000 | (a) | ........ |
| Clarion | ........ | 5 | 22 | 15 | 7 | 14 | 29 | ........ | 31,211 | 1,240 | 971 |
| Elk | ........ | ........ | 10 | 10 | ........ | 10 | 20 | ........ | 26,198 | 18,662 | 7,536 |
| Erie | ........ | 1 | 7 | 7 | ........ | 69 | 76 | ........ | 3,994 | 2,125 | 1,369 |
| Fayette | ........ | ........ | ........ | ........ | ........ | 4 | 4 | ........ | ........ | ........ | ........ |
| Forest | ........ | ........ | 3 | 3 | ........ | 11 | 14 | ........ | 3,700 | 400 | 900 |
| Greene | ........ | ........ | ........ | ........ | ........ | ........ | 1 | ........ | ........ | ........ | ........ |
| Indiana | ........ | ........ | 4 | 1 | 3 | 2 | 3 | 1 | 22,000 | (a) | ........ |
| Jefferson | ........ | ........ | 3 | 3 | ........ | 6 | 8 | 1 | 5,523 | 3,600 | 1,923 |
| McKean | 5 | 2 | 24 | 23 | 1 | 97 | 120 | 1 | 47,589 | 11,877 | 23,712 |
| Mercer | ........ | ........ | ........ | ........ | ........ | 7 | 5 | 2 | ........ | ........ | ........ |
| Potter | ........ | ........ | 4 | 4 | ........ | 6 | 10 | ........ | 6,078 | 2,400 | 3,678 |
| Venango | 5 | ........ | 39 | 34 | 5 | 101 | 135 | ........ | 67,470 | 32,400 | 35,070 |
| Warren | ........ | 1 | 1 | ........ | 1 | 6 | 6 | ........ | 800 | (a) | ........ |
| Washington | 1 | 2 | 24 | 23 | 1 | 51 | 70 | 7 | 101,596 | 24,250 | 39,446 |
| Westmoreland | 6 | 17 | 59 | 54 | 5 | 260 | 313 | 10 | 241,228 | 85,955 | 100,841 |

*a* Contract.

In the following table will be found a statement of the number of wells completed in Pennsylvania in each month of 1889, together with the number of dry holes and number of completed wells which were productive:

### WELLS COMPLETED IN PENNSYLVANIA IN 1889, BY MONTHS.

| MONTHS. | Total number of wells completed in each month. | Number of dry holes. | Number of wells producing. |
|---|---|---|---|
| Total | 239 | 32 | 207 |
| January | 27 | 2 | 25 |
| February | 9 | 2 | 7 |
| March | 13 | 1 | 12 |
| April | 12 | 2 | 10 |
| May | 13 | 4 | 9 |
| June | 17 | 5 | 12 |
| July | 17 | 3 | 14 |
| August | 21 | 5 | 16 |
| September | 19 | 1 | 18 |
| October | 23 | 1 | 22 |
| November | 29 | 1 | 28 |
| December | 39 | 5 | 34 |

In the following table will be found a statement of the number of wells producing at the close of December, 1888, and of each month of 1889:

PRODUCING WELLS.

| MONTHS. | Total number producing. | Total number abandoned. |
|---|---|---|
| 1888. | | |
| December 31 | 810 | 7 |
| 1889. | | |
| January 31 | 826 | 9 |
| February 28 | 831 | 2 |
| March 31 | 838 | 6 |
| April 30 | 857 | 2 |
| May 31 | 862 | 4 |
| June 30 | 874 | ........ |
| July 31 | 887 | 4 |
| August 31 | 902 | 2 |
| September 30 | 920 | 4 |
| October 31 | 941 | 2 |
| November 30 | 968 | 1 |
| December 31 | 999 | 4 |

## CAPITAL.

From the returns received the total amount of capital employed in the development, production, and transportation of natural gas in Pennsylvania in 1889 was $34,398,832. Of this amount $7,589,968 was reported as the value of the land and $26,808,864 as the value of other property.

The total number of acres of natural gas territory in Pennsylvania in 1889 was 277,430, of which 25,411 acres were owned and 252,019 leased. As stated above, the value of this land was $7,589,968, which would make the average price per acre $27.36, which is evidently the cost of the leases and not its value as gas-producing territory.

The value of rigs, wells, etc., is given as $3,757,961. As there were 999 producing wells at the close of 1889, the average value of each well was $3,762.

The total value of pipe lines, including right of way, in Pennsylvania is given as $18,955,018. The total number of feet of pipe line laid in this state at the close of 1889 was 18,813,574, which would make the average price per foot $1.01.

CAPITAL INVESTED IN THE NATURAL GAS INDUSTRY IN PENNSYLVANIA IN 1889.

| COUNTIES. | Total capital. | NUMBER OF ACRES OF NATURAL GAS LAND. | | | | VALUE OF PLANT. | | |
|---|---|---|---|---|---|---|---|---|
| | | Total acreage. | Owned. | Leased. | Value. | Rigs, wells, etc. | Pipe lines. | Other property. |
| Total | $34,398,832 | 277,430 | 25,411 | 252,019 | $7,589,968 | $3,757,961 | $18,955,018 | $4,095,885 |
| Allegheny | 992,325 | 6,602 | 66 | 6,536 | 108,206 | 140,000 | 488,000 | 256,119 |
| Armstrong | 60,000 | ........ | ........ | ........ | ........ | 20,000 | 30,000 | 10,000 |
| Beaver | 1,827,210 | 7,003 | 3 | 7,000 | 35,400 | 335,800 | 1,376,000 | 80,010 |
| Butler | 849,914 | 33,456 | 1 | 33,455 | 97,205 | 143,761 | 585,585 | 23,363 |
| Cambria | 30,000 | 40 | ........ | 40 | 7,000 | 15,000 | 8,000 | ........ |
| Clarion | 183,431 | 2,856 | 521 | 2,335 | 52,850 | 72,477 | 52,644 | 5,460 |
| Elk | 421,852 | 7,409 | 6,516 | 893 | 295,600 | 31,388 | 93,564 | 1,300 |
| Erie | 170,638 | 1,030 | 944 | 86 | 78,360 | 56,484 | 31,104 | 4,690 |
| Fayette | 100,000 | ........ | ........ | ........ | ........ | 100,000 | ........ | ........ |
| Forest | 145,900 | 1,801 | ........ | 1,801 | 65,100 | 25,700 | 47,100 | 8,000 |
| Greene | 3,200 | 6 | 1 | [illegible] | 500 | 2,000 | 500 | 200 |
| Indiana | 88,500 | 10,000 | ........ | 10,000 | 19,500 | 22,000 | 40,500 | 6,500 |
| Jefferson | 35,000 | 1,016 | ........ | 1,016 | 2,200 | 14,600 | 17,300 | 900 |
| McKean | 4,285,722 | 36,964 | 12,199 | 24,765 | 1,269,605 | 215,112 | 2,438,836 | 362,169 |
| Mercer | 30,000 | 1,010 | ........ | 1,010 | 2,000 | 2,500 | 25,000 | 500 |
| Potter | 334,119 | 6,158 | 2 | 6,156 | 137,737 | 50,294 | 119,268 | 26,820 |
| Venango | 3,049,797 | 64,541 | 2,799 | 61,742 | 510,288 | 127,941 | 1,739,255 | 672,313 |
| Warren | 40,800 | ........ | ........ | ........ | ........ | 10,300 | 30,000 | 500 |
| Washington | 2,387,394 | 27,548 | 32 | 27,516 | 577,775 | 261,883 | 1,348,639 | 199,097 |
| Westmoreland | 19,363,030 | 69,990 | 2,327 | 67,663 | 4,330,642 | 2,110,721 | 10,483,723 | 2,437,944 |

## LABOR AND WAGES.

The total number of employés engaged in the natural gas industry in Pennsylvania, as will be seen from the table given on the following page, was 3,282, more than one-half of whom were employed in the production of gas from

Westmoreland county. The total amount of wages paid these 3,282 persons was $1,092,709. Of the total number of employés, 145 were foremen or overseers, to whom was paid $126,424; 399 were mechanics, to whom was paid $207,210; 2,529 were laborers, to whom was paid $571,445; 1 boy under 16 years, to whom was paid $50; 202 males in office, to whom was paid $185,567, and 6 females in office, to whom was paid $2,013.

LABOR AND WAGES, BY COUNTIES.

| COUNTIES. | TOTAL. | | FOREMEN OR OVERSEERS. | | MECHANICS. | | LABORERS. | | BOYS UNDER 16 YEARS. | | OFFICE. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Males. | | Females. | |
| | Number. | Wages. | Number. | Wages. | Number. | Wages. | Number. | Wages. | Number. | Wages. | Number. | Wages. | Number. | Wages. |
| Total | 3, 282 | $1, 092, 709 | 145 | $126, 424 | 399 | $207, 210 | 2, 529 | $571, 445 | 1 | $50 | 202 | $185, 567 | 6 | $2, 013 |
| Allegheny | 224 | 21, 687 | 14 | 8, 800 | 50 | 1, 800 | 151 | 4, 577 | | | 9 | 6, 510 | | |
| Armstrong | 1 | 900 | 1 | 900 | | | | | | | | | | |
| Beaver | 77 | 47, 552 | 5 | 4, 418 | 28 | 17, 567 | 32 | 14, 932 | | | 12 | 10, 635 | | |
| Butler | 138 | 20, 875 | 5 | 3, 600 | 20 | 2, 764 | 110 | 13, 163 | | | 2 | 1, 300 | 1 | 48 |
| Cambria | 2 | 750 | 1 | 600 | | | 1 | 150 | | | | | | |
| Clarion | 75 | 4, 640 | 5 | 952 | | | 66 | 2, 248 | | | 4 | 1, 440 | | |
| Elk | 8 | 5, 225 | 5 | 3, 600 | | | 1 | 545 | | | 2 | 1, 080 | | |
| Erie | 5 | 564 | 2 | 245 | 1 | 3 | 1 | 16 | | | 1 | 300 | | |
| Fayette | 4 | 2, 520 | 1 | 720 | 2 | 1, 080 | | | | | 1 | 720 | | |
| Forest | 12 | 6, 900 | 2 | 1, 560 | 1 | 180 | 3 | 1, 560 | | | 6 | 3, 600 | | |
| Greene | 1 | 50 | 1 | 50 | | | | | | | | | | |
| Indiana | 2 | 1, 440 | 1 | 720 | | | | | | | 1 | 720 | | |
| Jefferson | 1 | 700 | 1 | 700 | | | | | | | | | | |
| McKean | 490 | 92, 350 | 13 | 12, 917 | 45 | 24, 272 | 394 | 22, 308 | | | 37 | 32, 808 | 1 | 45 |
| Mercer | 2 | 1, 646 | 1 | 1, 020 | 1 | 626 | | | | | | | | |
| Potter | 76 | 6, 821 | | | 12 | 1, 013 | 64 | 5, 808 | | | | | | |
| Venango | 229 | 121, 808 | 18 | 19, 288 | 38 | 20, 910 | 148 | 52, 232 | | | 23 | 28, 598 | 2 | 780 |
| Warren | 3 | 1, 500 | | | 2 | 913 | 1 | 587 | | | | | | |
| Washington | 113 | 36, 155 | 9 | 7, 851 | 4 | 1, 300 | 86 | 17, 284 | 1 | 50 | 13 | 9, 670 | | |
| Westmoreland | 1, 819 | 718, 626 | 60 | 58, 483 | 195 | 134, 782 | 1, 471 | 436, 035 | | | 91 | 88, 186 | 2 | 1, 140 |

In the following table is given a detailed statement of the number and class of employés, range of wages, etc., by counties:

CLASSIFIED WAGES IN PENNSYLVANIA, BY COUNTIES.

| CLASS OF LABOR. | Total. | ALLEGHENY. | | ARMSTRONG. | | BEAVER. | | BUTLER. | |
|---|---|---|---|---|---|---|---|---|---|
| | | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. |
| Total | 3, 282 | 224 | | 1 | | 77 | | 138 | |
| Presidents | 1 | | | | | | | | |
| Treasurers | 1 | | | | | | | | |
| Bookkeepers | 36 | 9 | $50 to $100 per month | | | 3 | $75 to $100 per month | 2 | $65 to $75 per month. |
| Clerks, male | 160 | | | | | 7 | $45 to $60 per month | | |
| Clerks, female | 4 | | | | | | | 1 | $48 per month. |
| Telegraph operators | 6 | | | | | | | | |
| Superintendents | 13 | 4 | $50 to $100 per month | | | 2 | $125 to $250 per month | | |
| Foremen or overseers | 130 | 9 | $40 to $85 per month | 1 | $75 per month | 5 | $70 to $82 per month | 5 | $10 to $100 per month. |
| Electricians | 1 | | | | | | | | |
| Inspectors | 34 | | | | | | | | |
| Station agents | 25 | | | | | | | | |
| Engineers | 2 | | | | | | | | |
| Plumbers or fitters | 146 | 50 | $2.25 per day | | | 12 | $1.75 to $2.50 per day | 1 | $1.50 per day. |
| Drillers | 61 | | | | | 8 | $5 per day | 16 | $3.50 to $3.75 per day. |
| Tool dressers | 22 | | | | | 8 | $3.50 per day | | |
| Carpenters | 21 | | | | | | | | |
| Fieldmen | 52 | | | | | | | | |
| Teamsters | 19 | | | | | | | | |
| Linemen | 23 | | | | | | | | |
| Warehousemen | 2 | | | | | | | | |
| Blacksmiths | 2 | | | | | | | | |
| Tongsmen | 69 | | | | | | | | |
| Watchmen | 7 | | | | | 1 | $40 per month | | |
| Mechanics | 153 | 1 | $60 per month | | | | | 22 | $2 to $3 per day. |
| Laborers | 2, 291 | 151 | $1 to $1.50 per day | | | 31 | $1.75 per day | 91 | $1.50 to $2 per day. |
| Boys under 16 years | 1 | | | | | | | | |

CLASSIFIED WAGES IN PENNSYLVANIA, BY COUNTIES—Continued.

| CLASS OF LABOR. | CAMBRIA. | | CLARION. | | ELK. | | ERIE. | |
|---|---|---|---|---|---|---|---|---|
| | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. |
| Total | 2 | | 75 | | 8 | | 5 | |
| Presidents | | | | | | | | |
| Treasurers | | | | | | | | |
| Bookkeepers | | | 2 | $25 to $40 per month | | | 1 | $25 per month. |
| Clerks, male | | | | | 2 | $40 to $50 per month | | |
| Clerks, female | | | | | | | | |
| Telegraph operators | | | | | | | | |
| Superintendents | | | 1 | $50 per month | | | | |
| Foremen or overseers | 1 | $50 per month | 5 | $1.50 to $2 per day | 4 | $30 to $150 per month | 2 | $1.25 to $2 per day. |
| Electricians | | | | | | | | |
| Inspectors | | | | | | | | |
| Station agents | | | | | | | | |
| Engineers | | | | | | | | |
| Plumbers or fitters | | | | | | | 1 | $2.25 per day. |
| Drillers | | | | | | | | |
| Tool dressers | | | | | | | | |
| Carpenters | | | | | | | | |
| Fieldmen | | | | | | | | |
| Teamsters | | | 5 | $4 per day | | | | |
| Linemen | | | | | 1 | $20 per month | | |
| Warehousemen | | | | | | | | |
| Blacksmiths | | | | | | | | |
| Tongsmen | | | | | | | | |
| Watchmen | | | | | | | | |
| Mechanics | | | | | | | | |
| Laborers | 1 | $1.50 per day | 62 | $1 to $2.25 per day | 1 | | 1 | $2 per day. |
| Boys under 16 years | | | | | | | | |

| CLASS OF LABOR. | FAYETTE. | | FOREST. | | GREENE. | | INDIANA. | |
|---|---|---|---|---|---|---|---|---|
| | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. |
| Total | 4 | | 12 | | 1 | | 2 | |
| Presidents | | | | | | | | |
| Treasurers | | | | | | | | |
| Bookkeepers | | | | | | | 1 | $60 per month. |
| Clerks, male | | | 6 | $40 to $60 per month | | | | |
| Clerks, female | | | | | | | | |
| Telegraph operators | | | | | | | | |
| Superintendents | 1 | $60 per month | | | | | 1 | $60 per month. |
| Foremen or overseers | 1 | $60 per month | 2 | $50 to $80 per month | 1 | $50 per month | | |
| Electricians | | | | | | | | |
| Inspectors | | | | | | | | |
| Station agents | | | | | | | | |
| Engineers | | | | | | | | |
| Plumbers or fitters | | | | | | | | |
| Drillers | | | | | | | | |
| Tool dressers | | | | | | | | |
| Carpenters | | | | | | | | |
| Fieldmen | | | | | | | | |
| Teamsters | | | | | | | | |
| Linemen | | | | | | | | |
| Warehousemen | | | | | | | | |
| Blacksmiths | | | | | | | | |
| Tongsmen | | | | | | | | |
| Watchmen | | | | | | | | |
| Mechanics | 2 | $2 per day | 1 | $2 per day | | | | |
| Laborers | | | 3 | $2 per day | | | | |
| Boys under 16 years | | | | | | | | |

CLASSIFIED WAGES IN PENNSYLVANIA, BY COUNTIES—Continued.

| CLASS OF LABOR. | JEFFERSON. |  | M'KEAN. |  | MERCER. |  | POTTER. |  |
|---|---|---|---|---|---|---|---|---|
|  | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. |
| Total | 1 |  | 490 |  | 2 |  | 76 |  |
| Presidents |  |  |  |  |  |  |  |  |
| Treasurers |  |  |  |  |  |  |  |  |
| Bookkeepers |  |  | 17 | $50 to $75 per month |  |  |  |  |
| Clerks, male |  |  | 20 | $50 to $88 per month |  |  |  |  |
| Clerks, female |  |  | 1 | $45 per month |  |  |  |  |
| Telegraph operators |  |  |  |  |  |  | 3 | $2 per day. |
| Superintendents |  |  |  |  |  |  |  |  |
| Foremen or overseers | 1 | $58.33⅓ per month | 13 | $45 to $166.66⅔ per month | 1 | $85 per month |  |  |
| Electricians |  |  |  |  |  |  |  |  |
| Inspectors |  |  |  |  |  |  |  |  |
| Station agents |  |  |  |  |  |  |  |  |
| Engineers |  |  |  |  |  |  |  |  |
| Plumbers or fitters |  |  | 31 | $1.25 to $2 per day |  |  |  |  |
| Drillers |  |  | 14 | $3.75 to $4 per day |  |  | 6 | $4 per day. |
| Tool dressers |  |  | 2 | $3 per day |  |  | 6 | $3.50 per day. |
| Carpenters |  |  |  |  |  |  |  |  |
| Fieldmen |  |  |  |  |  |  | 4 | $2 per day. |
| Teamsters |  |  |  |  |  |  |  |  |
| Linemen |  |  |  |  |  |  | 3 | $2 per day. |
| Warehousemen |  |  |  |  |  |  |  |  |
| Blacksmiths |  |  |  |  |  |  |  |  |
| Tongsmen |  |  |  |  |  |  |  |  |
| Watchmen |  |  |  |  |  |  | 5 | $2 per day. |
| Mechanics |  |  | 20 | $1.90 to $3 per day | 1 | $2 per day |  |  |
| Laborers |  |  | 372 | $1.50 to $2 per day |  |  | 49 | $1.50 per day. |
| Boys under 16 years |  |  |  |  |  |  |  |  |

| CLASS OF LABOR. | VENANGO. |  | WARREN. |  | WASHINGTON. |  | WESTMORELAND. |  |
|---|---|---|---|---|---|---|---|---|
|  | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. |
| Total | 229 |  | 3 |  | 113 |  | 1, 819 |  |
| Presidents |  |  |  |  | 1 | $150 per month |  |  |
| Treasurers |  |  |  |  | 1 |  |  |  |
| Bookkeepers |  |  |  |  | 1 | $75 per month |  |  |
| Clerks, male | 23 | $72 to $145 per month |  |  | 9 | $40 to $100 per month | 93 | $50 to $200 per month. |
| Clerks, female | 2 | $30 to $45 per month |  |  |  |  |  |  |
| Telegraph operators |  |  |  |  |  |  | 3 | $75 per month. |
| Superintendents |  |  |  |  | 1 | $125 per month | 3 | $100 to $200 per month. |
| Foremen or overseers | 18 | $50 to $187.50 per month |  |  | 9 | $40 to $90 per month | 52 | $50 to $115 per month. |
| Electricians |  |  |  |  |  |  | 1 | $60 per month. |
| Inspectors | 1 | $2 per day |  |  |  |  | 33 | $65 per month. |
| Station agents |  |  |  |  |  |  | 25 | $65 per month. |
| Engineers |  |  |  |  |  |  | 2 | $75 to $150 per month. |
| Plumbers or fitters | 1 | $2 per day |  |  |  |  | 50 | $2.25 per day. |
| Drillers | 6 | $4 per day |  |  |  |  | 11 | $2 to $4.50 per day. |
| Tool dressers | 6 | $4 per day |  |  |  |  |  |  |
| Carpenters | 12 | $3.50 per day |  |  |  |  | 9 | $2.75 per day. |
| Fieldmen | 48 | $50 per month |  |  |  |  |  |  |
| Teamsters | 8 | $5 per day |  |  |  |  | 6 | $50 per month. |
| Linemen |  |  |  |  |  |  | 19 | $55 per month. |
| Warehousemen |  |  |  |  |  |  | 2 | $2 per day. |
| Blacksmiths |  |  |  |  |  |  | 2 | $60 per month. |
| Tongsmen | 12 | $2.25 per day |  |  |  |  | 57 | $2 per day. |
| Watchmen |  |  |  |  |  |  | 1 | $65 per month. |
| Mechanics | 4 | $50 to $70 per month | 2 | $2 per day | 4 | $62 per month | 96 | $2 to $3.80 per day. |
| Laborers | 88 | $1 to $2 per day | 1 | $2 per day | 86 | $1.25 to $2 per day | 1, 354 | $1.25 to $2 per day. |
| Boys under 16 years |  |  |  |  | 1 | $50 per month |  |  |

### TOTAL EXPENDITURES FOR MATERIALS.

The total expenditures during 1889 in Pennsylvania for materials in building rigs, drilling wells, operating, shutting in, and caring for wells, pipe, couplings, etc., in building and repairing pipe lines, fitting, torpedoing, etc., were $4,963,780. Of this amount $984,344 were expended in Venango county and but $712,027 in Westmoreland county. This would seem to be an error, since there were 59 wells completed in Westmoreland county during 1889 and but 39 wells in Venango county. This difference is easily explained when we consider that a great many of the wells in Westmoreland county were drilled by contract, which expense is not included in the total of expenditures given in the table below.

TOTAL EXPENDITURES FOR MATERIAL DURING 1889, BY COUNTIES.

| COUNTIES. | Total. | Building rigs. | Drilling wells. | Operating, shutting in, and caring for wells. | Pipe, couplings, etc., in building and repairing pipe lines. | Used in fitting. | TORPEDOES. | | All other material. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Number. | Value. | |
| Total | $4,963,780 | $113,022 | $326,674 | $188,550 | $855,192 | $227,926 | 55 | $6,167 | $3,246,249 |
| Allegheny | 53,125 | 900 | 5,000 | | 44,442 | 1,935 | 1 | 68 | 780 |
| Beaver | 907,730 | 12,000 | 32,800 | 22,400 | 6,130 | 54,360 | 1 | 40 | 780,000 |
| Butler | 168,961 | 5,417 | 17,075 | 20,780 | 15,914 | 5,006 | | | 104,769 |
| Cambria | 485 | | | 400 | 85 | | | | |
| Clarion | 40,898 | 2,078 | 1,950 | 1,847 | 33,455 | 408 | 1 | 60 | 1,100 |
| Elk | 78,095 | 950 | 5,000 | 4,700 | 65,607 | 1,200 | 4 | 338 | 300 |
| Erie | 3,636 | | 600 | 800 | 1,122 | | 3 | 160 | 954 |
| Forest | 3,500 | | | 900 | 2,400 | | | | 200 |
| Greene | 700 | | | | 500 | | | | 200 |
| Indiana | 4,850 | 2,300 | 2,400 | | | | 1 | 150 | |
| Jefferson | 2,440 | 325 | 2,000 | | | | 2 | 115 | |
| McKean | 1,657,794 | 19,093 | 54,500 | 27,541 | 45,658 | 83,700 | 39 | 4,986 | 1,422,316 |
| Potter | 240,423 | 5,364 | 8,800 | 1,896 | 9,642 | 6,062 | | | 208,659 |
| Venango | 984,344 | 34,495 | 70,600 | 70,246 | 69,661 | 50,433 | | | 688,909 |
| Warren | 236 | | | | 236 | | | | |
| Washington | 104,536 | 10,500 | 43,057 | 14,247 | 31,511 | 2,473 | 3 | 250 | 2,498 |
| Westmoreland | 712,027 | 19,600 | 82,892 | 22,793 | 528,829 | 22,349 | | | 35,564 |

### STATISTICS OF THE PRODUCTION OF NATURAL GAS IN PENNSYLVANIA IN 1889.

Below will be found a condensed statement of the figures regarding the development, production, and consumption of natural gas in Pennsylvania in 1889:

| | |
|---|---|
| Total amount received for natural gas produced in 1889 | $8,287,383 |
| Coal displaced (tons of 2,000 pounds) | 6,863,062 |
| Value of same | $11,593,989 |

#### USES.

| | |
|---|---|
| Total number of fires for cooking and heating | 280,484 |
| Total number of iron rolling mills supplied | 58 |
| Total number of steel works supplied | 15 |
| Total number of glass works supplied | 69 |
| Total number of gas companies supplied | 8 |
| Total number of other industrial establishments supplied | 1,604 |

#### WELLS.

| | |
|---|---|
| Number of wells drilling December 31, 1888 | 18 |
| Number of wells drilling December 31, 1889 | 31 |
| Number of wells completed in 1889 | 239 |
| Producing wells completed in 1889 | 207 |
| Dry holes completed in 1889 | 32 |
| Number of wells producing December 31, 1888 | 810 |
| Number of wells producing December 31, 1889 | 999 |
| Number of wells abandoned in 1889 | 47 |
| Total cost of drilling wells, including drive pipe, casing, etc. | $683,709 |
| Labor | $208,454 |
| Materials | $231,824 |

### CAPITAL.

| | |
|---|---|
| Number of acres of natural gas land: | |
| Owned | 25,411 |
| Leased | 252,019 |
| Total | 277,430 |
| Total value of land | $7,589,968 |
| Total value of rigs, wells, etc | 3,757,961 |
| Total value of pipe lines | 18,955,018 |
| Total value of other property and improvements | 4,095,885 |
| Total capital invested in lands, wells, etc., and used in the business | 34,398,832 |

### LABOR AND WAGES.

| | |
|---|---|
| Number of foremen or overseers | 145 |
| Number of mechanics | 399 |
| Number of laborers | 2,529 |
| Number of boys under 16 years | 1 |
| Number of office force, males | 202 |
| Number of office force, females | 6 |
| Total number of employés | 3,282 |
| Wages paid foremen or overseers | $126,424 |
| Wages paid mechanics | 207,210 |
| Wages paid laborers | 571,445 |
| Wages paid boys under 16 years | 50 |
| Wages paid office force, males | 185,567 |
| Wages paid office force, females | 2,013 |
| Total wages paid employés | 1,092,709 |

### EXPENDITURES FOR MATERIALS, ETC.

| | |
|---|---|
| Total amount expended in building rigs | $113,022 |
| Total amount expended in drilling wells | 326,674 |
| Total amount expended in operating, shutting in, and caring for wells | 188,550 |
| Total amount expended in pipe, couplings, etc., in building and repairing pipe lines | 855,192 |
| Total amount expended in fitting | 227,926 |
| Total amount expended for torpedoes | 6,167 |
| Total amount expended for all other materials | 3,246,249 |
| Total expenditures for materials | 4,963,780 |

## OHIO.

There are in Ohio four geological horizons supplying natural gas in commercial quantities. These are in the order of their occurrence, the most recent being named first, (1) the Berea grit, (2) the Ohio shale, (3) the Clinton limestone, and (4) the Trenton limestone.

The Ohio shale yields low-pressure gas in small quantities. Its area is limited to a belt along Lake Erie between Black river and the Pennsylvania line. It was the gas from this horizon which was utilized at Fredonia, New York, as early as 1821, and that burned at the lighthouse at Barcelona, near Westfield, had its source in these shales. At a much later date, but still more than a score of years ago, Erie, Pennsylvania, began to use natural gas in a small way, all the supply being derived from the shales that make the underlying rocks of this region. The lake shore towns of Ohio were not far behind in following the example of Erie. Painesville and Cleveland in particular made a trial of the shales as a source of gas, and secured a small but useful supply 20 years ago. Many wells were drilled along the shale belt in the oil excitement of 1860–1865, but none of these were in any reasonable degree successful, except in disclosing the presence of gas within the formation. The gas from this shale is essentially marsh gas, with small percentages of the more complex hydrocarbons, and is usually free from sulphur, differing in this respect from the gas from the limestone field. It is low pressure, its closed pressure never probably exceeding 100 pounds. Shale gas wells are small producers, the maximum production never passing 100,000 cubic feet a day, very few of them reaching 20,000, and many giving no more than 10,000, and some being as low as 1,500. The gas supply from this shale, though small, is reasonably permanent. Wells do not exhaust a large territory, and the drilling is simple and inexpensive. They require little or no casing, and after a dwelling is piped for gas it will be comparatively inexpensive to drill a new well a few rods from the old one when the first is exhausted. This fact as to the permanence of shale gas has little or no bearing on the question of the permanency of the supply of gas from high-pressure wells. Shale gas differs essentially in the conditions attending its occurrence and production, and furnishes no rules for judging the gas from other horizons in Ohio. The 3 other horizons named furnish high-pressure gas, though they are by no means of equal importance.

The gas territory depending upon the Berea grit for its supply is in the southeastern and middle eastern counties of the state bordering on Pennsylvania and West Virginia. It is of little importance compared with the territory farther west. Professor Orton, who supplied most of the information about the occurrence of natural gas in Ohio, suggests that though the drill taps the gas in the Berea grit its source is the Ohio shale, which underlies this whole territory with a thickness never less than 600 feet, and for much of the area is three or four times greater than that.

As stated above, the Berea grit, which Professor Orton thinks is the same as the Gantz sand of Washington, Pennsylvania, furnishes but small supplies of gas. At the close of 1889 Cambridge was the only town in the state that derived its supply from this rock. The wells were small, none exceeding 750,000 feet a day. Some high-pressure wells (500 pounds) of large production were struck near Marietta. Near the close of the year a little gas was also produced from this rock near East Liverpool, and at Mount Vernon a well yielding 100,000 feet a day was drilled. The famous Neff wells, in the northern part of Coshocton county, the first of which were drilled in 1865, still continue to produce, though the daily yield is small.

The gas is still utilized in the manufacture of lampblack, this special manufacture originating here. Mr. Neff worked out unaided all the questions connected with it years before it was attempted elsewhere. The wells now require constant care, but their record is an important one, as it shows how long the gas may be eked out even when the salt water accompanies it.

During the year 1889 the developments in the Clinton limestone region were of great importance. The first display of gas in this rock was at Fremont, the shallow wells of that town deriving their gas from the Clinton. It was at Lancaster, however, that a large supply of high-pressure gas was first struck in this formation, which is at Lancaster some 1,000 feet above the Trenton. The Clinton is at Lancaster some 2,000 feet deep. It is a highly crystalline limestone, included between 2 beds of red rock, the upper one being the famous fossil ore. At Newark and Thurston gas was also found in the Clinton. The supply at Newark seemed larger than at Lancaster.

The most important gas horizon in Ohio is the Trenton limestone, which is the rock in which the supplies of the Findlay and adjacent fields are found. The discovery of gas at Findlay in this horizon in 1885 was of great importance geologically and commercially. It discloses the fact, before unsuspected, that the limestone of the lower silurian age, and at the bottom of this great division of geological time, contained immense stores of gas. Commercially it has resulted in bringing into the section of Ohio in which it has been found a vast amount of capital for investment in manufacturing industries and in stimulating the search for gas in Indiana. The first discovery of gas in Findlay in recent times was made in October, 1836, in digging a well. In 1838 gas from another water well was conducted by wooden tubes into the fireplace in one of the living rooms of the house of Daniel Foster and burned from an old gun barrel. It was not until 1884, following the great discoveries in Pennsylvania, that the Findlay Natural Gas Company, the pioneer company in the search for gas in this region, began to drill. In November of that year gas was struck in the limestone rock at a depth of 1,100 feet.

Though the Findlay gas field was developed by drilling the first well in November, 1884, and by the wells of 1885, it was not until the "drilling in" of the great Karg well, on January 20, 1886, that the possibilities of the field were made evident, and it was shown that this territory could produce wells of the first class, even when judged by the standard of the great Pennsylvania wells. The excitement following the striking of this well can hardly be conceived. Its immense production, the force with which the gas escaped and its velocity, the light of the blazing gas, which could be seen at night 40 miles distant, all conspired to lead to that vigorous search for gas which immediately followed.

In composition this gas reaches the highest standard of excellence, as is apparent from the following table of analyses made for the United States geological survey by Professor C. C. Howard, of Columbus:

COMPOSITION OF NATURAL GAS FROM THE TRENTON LIMESTONE, OHIO.

| CONSTITUENTS. | Findlay. | Fostoria. | Saint Marys. |
|---|---|---|---|
| Total | 100.00 | 100.00 | 100.00 |
| Hydrogen | 1.64 | 1.89 | 1.74 |
| Marsh gas | 93.35 | 92.84 | 93.85 |
| Olefiant gas | 0.35 | 0.20 | 0.20 |
| Carbonic oxide | 0.41 | 0.55 | 0.44 |
| Carbonic acid | 0.25 | 0.20 | 0.23 |
| Oxygen | 0.39 | 0.35 | 0.35 |
| Nitrogen | 3.41 | 3.82 | 2.98 |
| Sulphureted hydrogen | 0.20 | 0.15 | 0.21 |

At the close of 1889 the chief fields of the Trenton limestone gas were in Hancock, Wood, Auglaize, and Mercer counties. The largest wells ever struck in this field were in 1889, though as a whole the field was declining. The Mellott well, near Stuartsville, 6 miles north of Findlay, had an open pressure in the casing of 28 pounds. This stands for a daily production of about 28,000,000 cubic feet. A new well recently drilled by the Northwestern company near Bairdstown, Wood county, is reported to have shown the amazing open pressure of 45 pounds in the casing. This stands for about 33,000,000 cubic feet per day. The Karg well was long counted the wonder of the world, its daily volume at its best being about 14,000,000 feet.

The industrial development of northwestern Ohio, as the result of the discovery of gas, has been remarkable. Leaving out of account those of less than 1,000 inhabitants, the towns using gas at the close of 1889 were Springfield, Greenville, Wapakoneta, Van Wert, Delphos, Sandusky, and Bellevue. Findlay, Lima, Bowling Green, Fostoria, Fremont, Tiffin, Carey, Kenton, Saint Marys, Troy, Piqua, Sidney, Celina, and other towns had been previously supplied. The Northwestern Ohio Gas Company has also laid a large line to the Michigan boundary, designed to furnish domestic fuel to Detroit.

The uses to which natural gas was put will be seen from the tables given below. Findlay had at the close of the year 154 glass pots, nearly half of them added in 1889. A large volume of other manufacturing interests has also been brought in. An equal or, at least, a similar enlargement has gone forward in Tiffin and in Fremont. Fostoria is also well to the front in this remarkable expansion. Bowling Green has also made some noteworthy advances.

Fostoria and Tiffin both own pipe lines to the great gas fields, built by public funds. The gas that they obtain from wells of their own drilling on lands that they have leased for this purpose they supply, at either nominal or very low rates, to the manufacturing companies, counting on the growth of the towns for their returns. The gas furnished on these terms is naturally used in a lavish way.

Toledo is supplied by 2 pipe lines, owned by the Northwestern Ohio company, and, in addition, the city is preparing at great outlay of funds, to be raised by bonding the town, to build a line for itself from the Hancock county field, where it has leased gas lands and drilled wells on a large scale.

### PRODUCTION.

In the following table will be found a statement of the total production of natural gas in Ohio during 1889, by counties. The value of this gas, as reported, was $1,120,997; the amount of coal displaced by its use was 1,660,456 tons, valued at $5,123,569, and the amount of wood displaced 24,130 cords, valued at $92,100. The total value, therefore, of the coal and wood displaced, which is $5,215,669, is regarded as the value of gas consumed in Ohio in 1889. As will be seen from the table, the largest production from any county was Hancock, in which Findlay is located, and which has been one of the most productive gas regions in the United States. Almost one-third of all the gas found in Ohio in 1889 was produced in this county.

No value is given for gas produced in Knox, Coshocton, and Marion counties, it having all gone to waste.

PRODUCTION OF NATURAL GAS IN OHIO IN 1889, BY COUNTIES.

| COUNTIES. | Total value. | COAL DISPLACED. | | WOOD DISPLACED. | |
|---|---|---|---|---|---|
| | | Tons. | Value. | Cords. | Value. |
| Total | $1,120,997 | 1,660,456 | $5,123,569 | 24,130 | $92,100 |
| Allen | 3,475 | | | 2,000 | 5,000 |
| Ashtabula | 3,655 | 870 | 5,075 | | |
| Auglaize | 135,112 | 59,000 | 178,250 | 21,250 | 85,000 |
| Brown | 30 | 7 | 30 | | |
| Butler | 60 | 24 | 110 | | |
| Clark | 50 | 15 | 60 | | |
| Columbiana | 4,782 | 2,720 | 4,620 | | |
| Cuyahoga | 1,200 | 233 | 1,150 | | |
| Darke | 1,300 | 400 | 1,300 | | |
| Fairfield | 36,000 | 20,150 | 41,400 | | |
| Guernsey | 15,530 | 9,012 | 18,048 | | |
| Hancock | 432,745 | 1,185,869 | 3,585,453 | 400 | 1,000 |
| Hardin | 150 | 30 | 210 | | |
| Harrison | 30 | 20 | 30 | | |
| Henry | 2,100 | 605 | 2,420 | | |
| Hocking | 250 | 100 | 250 | | |
| Logan | 584 | 172 | 600 | | |
| Lorain | 2,955 | 1,222 | 2,622 | | |
| Lucas | 7,469 | 1,650 | 7,563 | | |
| Mercer | 256,924 | 110,900 | 272,525 | | |
| Muskingum | 6,000 | | | | |
| Ottawa | 1,000 | 300 | 1,050 | | |
| Sandusky | 5,360 | 2,815 | 6,575 | | |
| Washington | 1,500 | 400 | 1,600 | | |
| Williams | 1,610 | 800 | 2,550 | | |
| Wood | 22,483 | 166,553 | 625,450 | 480 | 1,100 |
| Wyandot | 178,643 | 96,589 | 364,628 | | |

## USES.

As given in the following table, the total number of fires using natural gas for cooking and heating in Ohio in 1889 was 70,050. Of this total number almost four-fifths were in Hancock, Mercer, Wood, and Wyandot counties. The number of iron rolling mills supplied was 5, steel works 5, glass works 31, and other industrial establishments 278. Of the glass works supplied, 11 were located in Hancock county, or in the vicinity of Findlay, and 16 in Wood county, in the neighborhood of Bowling Green.

It will be seen from the table that no use was made of gas produced in Knox, Coshocton, and Marion counties, it having been allowed to waste, as previously stated.

USES TO WHICH NATURAL GAS PRODUCED IN OHIO IN 1889 WAS PUT.

| COUNTIES. | Fires for cooking and heating. | Iron rolling mills. | Steel works. | Glass works. | Other industrial establishments. |
|---|---|---|---|---|---|
| Total | 70,050 | 5 | 5 | 31 | 278 |
| Allen | 200 | | | | |
| Ashtabula | 125 | | | | 1 |
| Auglaize | 8,191 | | 2 | | 28 |
| Brown | 2 | | | | |
| Butler | 4 | | | | |
| Clark | 4 | | | | |
| Columbiana | 152 | | | | 3 |
| Cuyahoga | 71 | | | | |
| Darke | 73 | | | | 63 |
| Fairfield | 3,416 | | | | 5 |
| Guernsey | 1,303 | | | | 1 |
| Hancock | 18,893 | 4 | | 11 | 70 |
| Hardin | 6 | | | | |
| Harrison | | | | | 1 |
| Henry | 150 | | | | |
| Hocking | | | 1 | | |
| Logan | 46 | | | | |
| Lorain | 77 | | | | 2 |
| Lucas | 458 | | | | |
| Mercer | 14,007 | 1 | 2 | 2 | 49 |
| Muskingum | 500 | | | | |
| Ottawa | 20 | | | | 5 |
| Sandusky | 273 | | | | 4 |
| Washington | 100 | | | | |
| Williams | 135 | | | | |
| Wood | 10,144 | | | 16 | 43 |
| Wyandot | 11,700 | | | 2 | 3 |

## WELLS.

The total number of wells producing natural gas in Ohio at the close of 1889 was 448, which was 161 more than at the beginning of the year. During the year 196 wells were completed, of which 180 were productive and 16 dry holes, and 38 wells were abandoned. The total cost of completing these 196 wells was reported as $331,212, of which $66,836 was expended for labor and $81,778 for materials. These amounts do not include work done by contract, as no separation could be made of the cost into amounts expended for labor and materials.

WELL RECORD, BY COUNTIES.

| COUNTIES. | DRILLING WELLS. |  | WELLS COMPLETED IN 1889. |  |  | NUMBER OF WELLS PRODUCING. |  | Number abandoned in 1889. | Total cost of drilling wells, including drive pipe, casing, etc. | DETAIL OF COST. |  |
|---|---|---|---|---|---|---|---|---|---|---|---|
|  | December 31, 1888. | December 31, 1889. | Total. | Producing. | Dry holes. | December 31, 1888. | December 31, 1889. |  |  | Labor. | Materials. |
| Total | 4 | 10 | 196 | 180 | 16 | 287 | 448 | 38 | $331, 212 | $66, 836 | $81, 778 |
| Allen |  |  |  |  |  | 4 | 4 |  |  |  |  |
| Ashtabula |  |  | 4 | 4 |  | 11 | 15 |  | 1, 650 | 1, 000 | 650 |
| Auglaize |  |  | 12 | 12 |  | 22 | 33 | 1 | 23, 400 | 3, 345 | 4, 055 |
| Brown |  |  |  |  |  | 3 | 3 |  |  |  |  |
| Butler | 1 |  | 1 | 1 |  | 4 | 2 | 3 | 1, 000 |  |  |
| Clark |  |  |  |  |  | 2 | 2 |  |  |  |  |
| Columbiana |  |  | 2 | 2 |  | 10 | 10 | 2 | 1, 630 | 1, 030 | 600 |
| Coshocton |  |  |  |  |  | 4 | 4 |  |  |  |  |
| Cuyahoga |  |  | 8 | 8 |  | 10 | 18 |  | 3, 211 | 200 | 100 |
| Darke |  |  |  |  |  | 5 | 4 | 1 |  |  |  |
| Fairfield |  | 1 | 4 | 2 | 2 | 2 | 4 | 2 | 19, 100 |  |  |
| Guernsey |  |  | 9 | 8 | 1 | 16 | 24 | 1 | 8, 500 | 4, 000 | 2, 000 |
| Hancock | 2 | 5 | 78 | 78 |  | 31 | 117 | 1 | 132, 562 | 12, 245 | 34, 760 |
| Hardin |  |  | 8 | 4 | 4 |  | 3 | 5 | 13, 000 | 800 | 2, 200 |
| Harrison |  |  | 3 | 2 | 1 | 1 | 3 | 1 | 6, 000 |  |  |
| Henry |  |  |  |  |  | 2 | 2 |  |  |  |  |
| Hocking |  |  |  |  |  | 2 | 1 | 1 |  |  |  |
| Knox |  |  |  |  |  | 2 | 2 |  |  |  |  |
| Logan |  |  | 1 | 1 |  | 1 | 1 | 1 | 1, 150 |  |  |
| Lorain |  |  | 8 | 7 | 1 | 21 | 25 | 3 | 4, 388 | 1, 920 | 2, 468 |
| Lucas |  |  | 3 | 2 | 1 | 9 | 8 | 4 | 4, 030 |  |  |
| Marion |  |  |  |  |  | 4 | 4 |  |  |  |  |
| Mercer | 1 | 2 | 23 | 23 |  | 19 | 41 | 1 | 65, 950 | 32, 500 | 25, 500 |
| Muskingum |  |  |  |  |  | 1 | 1 |  |  |  |  |
| Ottawa |  |  |  |  |  | 2 | 2 |  |  |  |  |
| Paulding |  |  | 1 |  | 1 |  |  |  | 1, 500 | 500 | 1, 000 |
| Sandusky |  |  | 2 | 2 |  | 3 | 5 |  | 3, 800 | 1, 800 | 2, 000 |
| Seneca |  |  | 1 |  | 1 |  |  |  | 1, 516 | 916 | 600 |
| Washington |  |  |  |  |  | 1 | 1 |  |  |  |  |
| Williams |  |  | 1 | 1 |  | 3 | 3 | 1 | 5, 000 |  |  |
| Wood |  | 2 | 22 | 21 | 1 | 58 | 70 | 7 | 28, 025 | 3, 860 | 3, 765 |
| Wyandot |  |  | 5 | 2 | 3 | 31 | 33 | 3 | 5, 800 | 2, 720 | 2, 080 |

In the following table will be found a statement of the number of wells completed in each month of 1889 in Ohio, together with the number which were producing and the number of dry holes:

WELLS COMPLETED IN OHIO IN 1889.

| MONTHS. | Total number of wells completed in each month. | Number of wells producing. | Number of dry holes. |
|---|---|---|---|
| Total | 196 | 180 | 16 |
| January | 17 | 16 | 1 |
| February | 11 | 11 |  |
| March | 11 | 9 | 2 |
| April | 13 | 12 | 1 |
| May | 10 | 10 |  |
| June | 17 | 17 |  |
| July | 12 | 11 | 1 |
| August | 33 | 31 | 2 |
| September | 24 | 22 | 2 |
| October | 19 | 15 | 4 |
| November | 14 | 13 | 1 |
| December | 15 | 13 | 2 |

In the following table is given the number of wells producing at the close of December, 1888, and at the close of each month of 1889, together with the number of wells abandoned during the year:

### PRODUCING AND ABANDONED WELLS.

| MONTHS. | Total number producing. | Total number abandoned. |
|---|---|---|
| 1888. | | |
| December 31 | 287 | 9 |
| 1889. | | |
| January 31 | 291 | 6 |
| February 28 | 302 | 1 |
| March 31 | 303 | 3 |
| April 30 | 314 | 2 |
| May 31 | 330 | .......... |
| June 30 | 347 | .......... |
| July 31 | 359 | 1 |
| August 31 | 390 | 1 |
| September 30 | 411 | 4 |
| October 31 | 428 | 5 |
| November 30 | 440 | 1 |
| December 31 | 448 | 5 |

### CAPITAL.

The total capital employed in the production of natural gas in Ohio in 1889 was $12,953,750, of which $3,241,679 represented the value of gas land owned and leased and $9,712,071 the value of other property. Of the capital invested in gas industry in Ohio by far the largest part was invested in 4 counties, Hancock, Mercer, Wood, and Wyandot. Findlay is in Hancock county; Dayton, Greenville, and Celina are supplied from the Mercer fields; Bowling Green is in Wood county, and Carey and Upper Sandusky are in Wyandot county.

In many cases the capital reported represents the value of the land and wells drilled without any production; that is, the venture which was exploited being a failure in securing a commercial supply of gas.

Of the $12,953,750 of capital, $3,241,679 is reported as the value of the 112,252 acres of gas land owned and leased. This would be at the rate of $28.88 an acre, which is probably, as has been explained elsewhere, an underestimate. It will also be noted, although natural gas land is reported as being owned in Allen, Knox, and Ottawa counties, no value is placed upon it in the column of value of lands. Its value is probably included in the value of the wells. In Hocking, Marion, and Muskingum counties no land is reported. The reason for this omission can not be ascertained.

The total value of property other than lands was $9,712,071, of which $1,702,051 represents the value of rigs, wells, etc., $6,418,342 the value of pipe lines, and $1,591,678 the value of all other property. As there were 448 wells producing in this state at the close of 1889, this would make the estimated value of each well about $3,799, which is probably a fair estimate, all things considered.

The total value of pipe lines is given as $6,418,342. The total number of feet of pipe line in this state was 6,124,615, which would make the value per foot about $1.05, which is a little more than the reported value of pipe line per foot in Pennsylvania.

The value of property other than pipe lines and wells is reported in this state as $1,591,678.

### CAPITAL INVESTED IN THE NATURAL GAS INDUSTRY IN OHIO IN 1889.

| COUNTIES. | Total capital. | NUMBER OF ACRES OF NATURAL GAS LAND. | | | | VALUE OF PLANT. | | |
|---|---|---|---|---|---|---|---|---|
| | | Total acreage. | Owned. | Leased. | Value. | Rigs, wells, etc. | Pipe lines. | Other property. |
| Total | $12, 953, 750 | 112, 252 | 3, 712 | 108, 540 | $3, 241, 679 | $1, 702, 051 | $6, 418, 342 | $1, 591, 678 |
| Allen | 11, 000 | 320 | | 320 | (*a*) | 4, 500 | 4, 500 | 2, 000 |
| Ashtabula | 21, 200 | 106 | 1 | 105 | 1, 850 | 6, 992 | 9, 843 | 2, 515 |
| Auglaize | 998, 400 | 8, 193 | 1 | 8, 192 | 362, 850 | 54, 350 | 506, 000 | 75, 200 |
| Brown | 4, 350 | 2 | 2 | | 100 | 4, 050 | 200 | |
| Butler | 2, 075 | 1 | 1 | | 400 | 1, 175 | 60 | 440 |
| Clark | 6, 000 | 800 | | 800 | 4, 000 | 600 | | 1, 400 |
| Columbiana | 72, 000 | 5, 252 | 202 | 5, 050 | 22, 100 | 17, 100 | 31, 800 | 1, 000 |
| Coshocton | 50, 000 | 3, 200 | | 3, 200 | 25, 000 | 6. 000 | 500 | 18, 500 |
| Cuyahoga | 14, 626 | 171 | 171 | | 4. 380 | 8, 276 | 1, 820 | 150 |
| Darke | 12, 000 | 4 | | 4 | 400 | 575 | 4, 000 | 7, 025 |
| Fairfield | 24, 645 | 7 | 7 | | 4, 950 | 17, 300 | 1, 925 | 470 |
| Guernsey | 307, 600 | 6, 900 | | 6, 900 | 40, 050 | 119, 450 | 130, 000 | 18, 100 |
| Hancock | 2, 822, 283 | 30, 038 | 931 | 29, 107 | 1. 221, 479 | 375, 775 | 1, 088, 912 | 136, 117 |
| Hardin | 20, 500 | 1, 300 | | 1, 300 | 5, 000 | 15, 000 | 500 | |
| Harrison | 26, 000 | 1, 000 | | 1, 000 | 10, 000 | 6, 705 | 160 | 9, 135 |
| Henry | 15, 000 | 2 | 2 | | 500 | 8, 500 | 6, 000 | |
| Hocking | 5, 000 | | | | | 5, 000 | | |
| Knox | 10, 000 | 900 | | 900 | (*a*) | 10, 000 | | |
| Logan | 11, 400 | 1 | 1 | | 50 | 6. 500 | 3, 500 | 1, 350 |
| Lorain | 42, 725 | 3, 058 | 358 | 2, 700 | 19, 150 | 19, 450 | 2, 625 | 1, 500 |
| Lucas | 69, 199 | 203 | 3 | 200 | 4, 182 | 21, 467 | 37, 317 | 6, 233 |
| Marion | 6, 325 | | | | | 6, 175 | 150 | |
| Mercer | 3, 748, 975 | 5, 992 | 380 | 5, 612 | 49, 900 | 135, 600 | 3, 126, 100 | 437, 375 |
| Muskingum | 125, 000 | | | | | 125, 000 | | |
| Ottawa | 4, 500 | 1 | 1 | | | 4, 000 | 500 | |
| Paulding | 1, 500 | 3, 000 | | 3, 000 | 1, 250 | 250 | | |
| Sandusky | 65, 100 | 741 | 427 | 314 | 51, 000 | 7, 900 | 6, 200 | |
| Seneca | 2, 515 | 3, 000 | | 3, 000 | 1, 000 | 500 | | 1, 015 |
| Washington | 4, 100 | 10 | | 10 | 100 | 4, 000 | | |
| Williams | 60, 500 | 1, 610 | | 1, 610 | 37, 324 | 16, 000 | 7, 176 | |
| Wood | 2, 474, 898 | 9, 451 | 870 | 8, 581 | 340, 570 | 651, 926 | 719, 583 | 762, 819 |
| Wyandot | 1, 914, 334 | 26, 989 | 354 | 26, 635 | 1, 034, 094 | 41, 935 | 728, 971 | 109, 334 |

*a* No value as natural gas land.

### LABOR AND WAGES.

The total number of employés reported in connection with production, transportation, and distribution of natural gas in Ohio in 1889 was 983, to whom were paid $241,218 in wages. The same remarks will apply here that have been made elsewhere, to the effect that labor engaged in drilling wells, laying pipe, etc., by contract, and wages paid are not included in this table. The same remark also can be made as to the difficulty that arises in connection with the classification given in this table.

### LABOR AND WAGES, BY COUNTIES.

| COUNTIES. | TOTAL. | | FOREMEN OR OVERSEERS. | | MECHANICS. | | LABORERS. | | BOYS UNDER 16 YEARS. | | OFFICE. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Males. | | Females. | |
| | Number. | Wages. | Number. | Wages. | Number. | Wages. | Number. | Wages. | Number. | Wages. | Number. | Wages. | Number. | Wages. |
| Total | 983 | $241, 218 | 59 | $40, 702 | 97 | $32, 997 | 757 | $125, 938 | 3 | $438 | 63 | $40, 337 | 4 | $806 |
| Allen | 3 | 1, 280 | | | 1 | 300 | 1 | 200 | | | 1 | 780 | | |
| Ashtabula | 6 | 2, 405 | 1 | 1, 000 | 4 | 936 | 1 | 469 | | | | | | |
| Auglaize | 36 | 16, 522 | 6 | 4, 667 | 7 | 4. 588 | 18 | 3, 115 | | | 5 | 4, 152 | | |
| Columbiana | 6 | 881 | 3 | 391 | | | 2 | 390 | | | 1 | 100 | | |
| Coshocton | 1 | 500 | 1 | 500 | | | | | | | | | | |
| Cuyahoga | 3 | 110 | | | 1 | 80 | 2 | 30 | | | | | | |
| Darke | 2 | 88 | 2 | 88 | | | | | | | | | | |
| Guernsey | 22 | 4, 989 | 1 | 900 | 1 | 250 | 16 | 1, 758 | 1 | 300 | 3 | 1, 781 | | |
| Hancock | 415 | 95, 283 | 11 | 7, 419 | 26 | 21, 626 | 367 | 59, 231 | 1 | 69 | 8 | 6, 642 | 2 | 296 |
| Hardin | 1 | 150 | | | 1 | 150 | | | | | | | | |
| Harrison | 1 | 360 | 1 | 360 | | | | | | | | | | |
| Henry | 2 | 300 | | | 1 | 150 | | | | | 1 | 150 | | |
| Logan | 4 | 170 | | | 2 | 75 | 1 | 35 | | | 1 | 60 | | |
| Lucas | 5 | 1, 787 | 2 | 1, 200 | 1 | 300 | 2 | 287 | | | | | | |
| Mercer | 91 | 30. 961 | 8 | 11, 195 | 33 | 3, 600 | 34 | 4, 442 | | | 15 | 11, 364 | 1 | 360 |
| Ottawa | 1 | 50 | | | 1 | 50 | | | | | | | | |
| Paulding | 10 | 500 | 2 | 120 | 8 | 380 | | | | | | | | |
| Sandusky | 2 | 650 | 1 | 500 | | | 1 | 150 | | | | | | |
| Williams | 3 | 155 | 1 | 60 | 1 | 25 | 1 | 70 | | | | | | |
| Wood | 83 | 34, 613 | 10 | 7, 266 | 9 | 487 | 51 | 17, 145 | | | 13 | 9, 715 | | |
| Wyandot | 286 | 49, 464 | 9 | 5, 036 | | | 260 | 38, 616 | 1 | 69 | 15 | 5, 593 | 1 | 150 |

In the following table is a more detailed classification of labor employed in Ohio in the natural gas industry in 1889 than that given in the preceding one:

### CLASSIFIED WAGES IN OHIO, BY COUNTIES.

| CLASS OF LABOR. | Total. | ALLEN. | | ASHTABULA. | | AUGLAIZE. | | COLUMBIANA. | |
|---|---|---|---|---|---|---|---|---|---|
| | | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. |
| Total | 983 | 3 | | 6 | | 36 | | 6 | |
| Bookkeepers | 9 | 1 | $65 per month | | | 1 | $5 per day | | |
| Clerks, male | 40 | | | | | 4 | $2 per day | 1 | $50 per month. |
| Clerks, female | 17 | | | | | | | | |
| Telegraph operators | 1 | | | | | | | | |
| Superintendents | 7 | | | 1 | $83.33⅓ per month | 2 | $5 per day | | |
| Foremen or overseers | 44 | | | | | 4 | $1.50 to $2.50 per day | 3 | $1 to $2.50 per day. |
| Electricians | 8 | | | | | | | | |
| Plumbers or fitters | 12 | 1 | $2 per day | | | 4 | $2 per day | | |
| Drillers | 32 | | | 2 | $2.50 per day | | | | |
| Tool dressers | 12 | | | | | | | | |
| Carpenters | | | | | | | | | |
| Fieldmen | 6 | | | | | 2 | $1.75 per day | | |
| Mechanics | 37 | | | 2 | $1.50 to $2.50 per day | 1 | $1.50 per day | | |
| Laborers | 755 | 1 | $1.50 per day | 1 | $1.50 per day | 18 | $1.25 to $1.50 per day | 2 | $1 per day. |
| Boys under 16 years | 3 | | | | | | | | |

CLASSIFIED WAGES IN OHIO, BY COUNTIES—Continued.

| CLASS OF LABOR. | COSHOCTON. | | CUYAHOGA. | | DARKE. | | GUERNSEY. | | HANCOCK. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. |
| Total | 1 | | 3 | | 2 | | 22 | | 415 | |
| Bookkeepers | | | | | | | | | 2 | $90 per month. |
| Clerks, male | | | | | | | 3 | $52 to $70 per month. | 6 | $55 to $100 per month. |
| Clerks, female | | | | | | | | | 2 | $50 per month. |
| Telegraph operators | | | | | | | | | | |
| Superintendents | 1 | $41.67 per month | | | | | | | | |
| Foremen or overseers | | | | | 2 | $2 per day | 1 | $3 per day | 11 | $2.50 to $3 per day. |
| Electricians | | | | | | | | | | |
| Plumbers or fitters | | | | | | | | | | |
| Drillers | | | | | | | | | 5 | $3.50 per day. |
| Tool dressers | | | | | | | | | | |
| Carpenters | | | | | | | | | | |
| Fieldmen | | | | | | | | | | |
| Mechanics | | | 1 | $2 per day | | | 2 | $1.25 to $5 per day | 21 | $3.25 to $4 per day. |
| Laborers | | | 2 | $1.25 to $2 per day | | | 15 | $1.25 to $1.50 per day | 367 | $1.25 to $2.25 per day. |
| Boys under 16 years | | | | | | | 1 | $14 to $25 per month | 1 | $12 to $14 per month. |

| CLASS OF LABOR. | HARDIN. | | HARRISON. | | HENRY. | | LOGAN. | |
|---|---|---|---|---|---|---|---|---|
| | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. |
| Total | 1 | | 1 | | 2 | | 4 | |
| Bookkeepers | | | | | 1 | $2.75 per day | 1 | $60 per month. |
| Clerks, male | | | | | | | | |
| Clerks, female | | | | | | | | |
| Telegraph operators | | | | | | | | |
| Superintendents | | | | | | | | |
| Foremen or overseers | | | 1 | $1 per day | | | | |
| Electricians | | | | | | | | |
| Plumbers or fitters | | | | | 1 | $1.75 per day | | |
| Drillers | | | | | | | | |
| Tool dressers | | | | | | | | |
| Carpenters | | | | | | | | |
| Fieldmen | | | | | | | | |
| Mechanics | 1 | $50 per month | | | | | 2 | $1.50 per day. |
| Laborers | | | | | | | 1 | $1.50 per day. |
| Boys under 16 years | | | | | | | | |

| CLASS OF LABOR. | LUCAS. | | MERCER. | | OTTAWA. | | PAULDING. | |
|---|---|---|---|---|---|---|---|---|
| | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. |
| Total | 5 | | 91 | | 1 | | 10 | |
| Bookkeepers | | | 1 | $1 per day | | | | |
| Clerks, male | | | | | | | | |
| Clerks, female | | | 14 | $2 per day | | | | |
| Telegraph operators | | | 1 | $30 per month | | | | |
| Superintendents | 2 | $50 per month | | | | | | |
| Foremen or overseers | | | | | | | 2 | $2 per day. |
| Electricians | | | 8 | $2.50 to $3 per day | | | | |
| Plumbers or fitters | | | | | | | | |
| Drillers | | | 16 | $2.25 per day | | | | |
| Tool dressers | | | 8 | $3.25 per day | | | 4 | $2.50 per day. |
| Carpenters | | | | | | | | |
| Fieldmen | | | 4 | $3.50 per day | | | | |
| Mechanics | 1 | $1.50 per day | | | 1 | $2 per day | 4 | $2 per day. |
| Laborers | 2 | $1 per day | 39 | $1 to $2 per day | | | | |
| Boys under 16 years | | | | | | | | |

CLASSIFIED WAGES IN OHIO, BY COUNTIES—Continued.

| CLASS OF LABOR. | SANDUSKY. | | WILLIAMS. | | WOOD. | | WYANDOT. | |
|---|---|---|---|---|---|---|---|---|
| | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. |
| Total | 2 | | 3 | | 83 | | 286 | |
| Bookkeepers | | | | | 2 | $57 per month | | |
| Clerks, male | | | | | 11 | $1 per day | 15 | $32 to $50 per month. |
| Clerks, female | | | | | | | 1 | $50 per month. |
| Telegraph operators | | | | | | | | |
| Superintendents | | | 1 | $2.50 per day | | | | |
| Foremen or overseers | 1 | $2 per day | | | 10 | $1.60 to $4.83 per day | 9 | $2.25 to $3 per day. |
| Electricians | | | | | | | | |
| Plumbers or fitters | | | | | 6 | $1.25 to $2.50 per day | | |
| Drillers | | | | | 9 | $3 to 3.50 per day | | |
| Tool dressers | | | | | | | | |
| Carpenters | | | | | | | | |
| Fieldmen | | | | | | | | |
| Mechanics | | | 1 | $2 per day | | | | |
| Laborers | 1 | $1.50 per day | 1 | $1.50 per day | 45 | $1.50 to $3 per day | 260 | $1.50 per day. |
| Boys under 16 years | | | | | | | 1 | $14 per month. |

The total expenditures in 1889 for materials in connection with the natural gas industry in Ohio are given as $5,722,865. For reasons already given, that is, the impossibility of getting at the expenditures at wells that have proved failures, and also the fact that work done by contract in some instances is not included in this table, it will be assumed that the figures given below are not the actual expenditures.

Of the amount $5,722,865 expended for material, $26,019 was expended in building rigs and $66,751 in drilling wells. As 196 wells were drilled in this state in 1889, it is evident that these figures are very much below the actual expenditures. The expense in operating, shutting in, and caring for wells was $44,710; that of building and repairing pipe lines $4,261,054, torpedoes $8,228, and used in fitting $970, and of all other materials $1,315,133.

TOTAL EXPENDITURES FOR MATERIALS DURING 1889, BY COUNTIES.

| COUNTIES. | Total. | Building rigs. | Drilling wells. | Operating, shutting in, and caring for wells. | Pipe, couplings, etc., in building and repairing pipe lines. | Used in fitting. | TORPEDOES. | | All other materials. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Number. | Value. | |
| Total | $5,722,865 | $26,019 | $66,751 | $44,710 | $4,261,054 | $970 | 86 | $8,228 | $1,315,133 |
| Allen | 2,500 | | | | 2,500 | | | | |
| Ashtabula | 1,260 | | 650 | 210 | 185 | 200 | | | 15 |
| Auglaize | 38,860 | 1,140 | 1,260 | 100 | 35,400 | | 6 | 960 | |
| Columbiana | 1,000 | 250 | 250 | 400 | 100 | | | | |
| Cuyahoga | 380 | | | 50 | 150 | 150 | 1 | 30 | |
| Fairfield | 978 | 500 | | 478 | | | | | |
| Guernsey | 9,010 | 2,260 | 4,200 | 1,700 | 200 | | 2 | 250 | 400 |
| Hancock | 1,117,747 | 6,345 | 34,715 | 9,741 | 686,567 | | 34 | 3,295 | 377,084 |
| Hardin | 5,800 | 650 | 800 | 3,500 | 80 | 120 | 5 | 450 | 200 |
| Harrison | 335 | | | | 160 | | 2 | 175 | |
| Henry | 175 | | | | 50 | | 1 | 125 | |
| Logan | 715 | | | | 580 | | 1 | 135 | |
| Lorain | 2,483 | 475 | 1,493 | 200 | 300 | | 1 | 15 | |
| Lucas | 405 | 100 | | | | | 2 | 205 | 100 |
| Mercer | 2,795,351 | 450 | 5,346 | 400 | 2,788,855 | | 3 | 300 | |
| Ottawa | 15 | | | | 15 | | | | |
| Paulding | 1,000 | | | | 1,000 | | | | |
| Sandusky | 1,025 | | | | 1,025 | | | | |
| Seneca | 600 | | 600 | | | | | | |
| Williams | 2,766 | | | 50 | 2,716 | | | | |
| Wood | 909,929 | 5,974 | 8,287 | 11,636 | 54,700 | 500 | 12 | 832 | 828,000 |
| Wyandot | 830,531 | 7,875 | 9,150 | 16,245 | 686,471 | | 16 | 1,456 | 109,334 |

### STATISTICS OF THE PRODUCTION OF NATURAL GAS IN OHIO IN 1889.

Below is a condensed statement of the figures regarding the development, production, and consumption of natural gas in Ohio in 1889:

| | |
|---|---|
| Total amount received for natural gas produced in 1889 | $1, 120, 997 |
| Coal displaced (tons of 2,000 pounds) | 1, 660, 456 |
| Value of same | $5, 123, 569 |
| Wood displaced (cords) | 24, 130 |
| Value of same | $92, 100 |

### USES.

| | |
|---|---|
| Total number of fires for cooking and heating | 70, 050 |
| Total number of iron rolling mills supplied | 5 |
| Total number of steel works supplied | 5 |
| Total number of glass works supplied | 31 |
| Total number of other industrial establishments | 278 |

### WELLS.

| | |
|---|---|
| Number of wells drilling December 31, 1888 | 4 |
| Number of wells drilling December 31, 1889 | 10 |
| Number of wells completed in 1889 | 196 |
| Number of producing wells completed in 1889 | 180 |
| Number of dry holes completed in 1889 | 16 |
| Number of wells producing December 31, 1888 | 287 |
| Number of wells producing December 31, 1889 | 448 |
| Number of wells abandoned in 1889 | 38 |
| Total cost of drilling wells, including drive pipe, casing, etc | $331, 212 |
| Labor | 66, 836 |
| Materials | 81, 778 |

### CAPITAL.

| | |
|---|---|
| Number of acres of natural gas land: | |
| Owned | 3, 712 |
| Leased | 108, 540 |
| Total | 112, 252 |
| Total value of land | $3, 241, 679 |
| Total value of rigs, wells, etc | 1, 702, 051 |
| Total value of pipe lines | 6, 418, 342 |
| Total value of other property and improvements | 1, 591, 678 |
| Total capital invested in lands, wells, etc., and used in the business | 12, 953, 750 |

### LABOR AND WAGES.

| | |
|---|---|
| Number of foremen or overseers | 59 |
| Number of mechanics | 97 |
| Number of laborers | 757 |
| Number of boys under 16 years | 3 |
| Number of office force, males | 63 |
| Number of office force, females | 4 |
| Total number of employés | 983 |
| Wages paid foremen or overseers | $40, 702 |
| Wages paid mechanics | 32, 997 |
| Wages paid laborers | 125, 938 |
| Wages paid boys under 16 years | 438 |
| Wages paid office force, males | 40, 337 |
| Wages paid office force, females | 806 |
| Total wages paid employés | 241, 218 |

### EXPENDITURES FOR MATERIALS, ETC.

| | |
|---|---|
| Total amount expended in building rigs | $26, 019 |
| Total amount expended in drilling wells | 66, 751 |
| Total amount expended in operating, shutting in, and caring for wells | 44, 710 |
| Total amount expended in pipe, couplings, etc., in building or repairing pipe lines | 4, 261, 054 |
| Total amount expended in fitting | 970 |
| Total amount expended for torpedoes | 8, 228 |
| Total amount expended for all other materials | 1, 315, 133 |
| Total expenditures for materials | 5, 722, 865 |

## INDIANA.

It is estimated that at the close of 1889 there were in Indiana about 2,500 square miles of what might be regarded as productive gas territory; that is, territory in which gas had been or probably would be obtained in paying quantities. The largest continuous body of this productive gasterritory is in the eastern central portion of the state, adjoining Ohio, extending from Wabash county on the north to Decatur county on the south, and from Randolph and Jay counties on the east to Howard, Tipton, and Hamilton counties on the west. The upper portion of this body of gas territory is widest, being some 70 miles across, gradually tapering to a point.

Outside of this largest body of gas territory a number of isolated patches have been found.

The accompanying table, prepared by Dr. A. J. Phinney for the American Manufacturer and Iron World, shows the area of the various gas fields in Indiana by counties at the close of 1889. It must be considered, however, as only approximately correct, though it embraces all the territory within which gas had been found in paying quantities. While it is probable that some gas territory can be found outside of the counties named, it is equally true that for every square mile of such outside productive territory there will be found an equal area of unproductive rock within the counties as mapped out.

At the beginning of 1889 a careful study of the field showed some 2,525 square miles of productive territory, arranged by counties as follows:

TABLE SHOWING THE NUMBER CF SQUARE MILES OF PRODUCTIVE GAS TERRITORY IN INDIANA AT THE BEGINNING OF 1889, BY COUNTIES.

| | SQUARE MILES. |
|---|---|
| Blackford | 180 |
| Decatur | 40 |
| Delaware | 350 |
| Grant | 350 |
| Hamilton | 200 |
| Hancock | 200 |
| Henry | 90 |
| Howard | 160 |
| Jay | 150 |
| Madison | 440 |
| Marion | 70 |
| Miami | 20 |
| Randolph | 80 |
| Rush | 40 |
| Shelby | 20 |
| Tipton | 120 |
| Wabash | 10 |
| Wayne | 5 |
| Total | 2,525 |

A small productive area was found in 1889 near Brookville, Franklin county, and another to the southeast of Winchester, Randolph county. Small areas were also discovered at Eagletown and Carmel, in the southwestern part of Hamilton county.

While all of the territory included in the estimate above given is probably productive, it is not all equally so. Rush, Decatur, and Shelby counties contained, with one or two exceptions, only wells of feeble flow. In other localities the production was only moderate, but every county named above has furnished a number of vigorous wells.

The great reservoir of natural gas in Indiana is the Trenton limestone. The chief structural feature of the state is the Cincinnati arch, which, while it does not make itself manifest on the surface, is no less an arch. It is claimed by Dr. Phinney that the portion of the arch in Indiana is the continuation of the main body, while the Findlay arch of Ohio is the smaller fork or branch. This arch is confined to the Trenton limestone and underlying formations. It is from 25 to 50 miles wide on its summit, and its slopes dip gradually away on either side.

As stated, this Cincinnati arch is the reservoir for the gas. The Trenton limestone being higher on this arch than in territory adjacent, the gas has not only found its way into it, but has sought the highest portion that was sufficiently porous to act as a reservoir. Over the greater portion of the arch, where the upper surface of the Trenton limestone lies lower than about 125 feet below sea level, it contains a porous stratum which is usually found near its upper surface at a depth ranging from 4 to 50 feet. This porous stratum is continuous over the whole gas area and over a large area adjacent to it, and where not filled with gas or oil contains salt water. Its thickness varies from 1 to 30 feet. Dr. Phinney thinks it probable that the different portions of the Indiana field are in communication through this porous rock. Professor Orton has shown that the gas-bearing porous stratum of the Trenton limestone is magnesian, while the more compact rock is a carbonate.

It has been noticed that the most vigorous wells are not as a rule found in the higher portion of the field. Wells situated high on the arch are also liable to suffer if drilled too deep or if the drill is sunk too deep into the Trenton rock before torpedoing the well.

## PRODUCTION.

The total amount received for natural gas produced in Indiana in 1889 was $1,362,472, as returned on the various schedules. The total amount of coal displaced by this gas was 716,461 tons, valued at $2,002,762. There were also 44,888 cords of wood displaced, valued at $72,940. This would make the total value of natural gas, estimated by fuel displacement, $2,075,702. It has been more difficult to arrive at the value of natural gas in Indiana than in any other state. Much of the gas was used in industrial establishments, which either received it free or at a nominal rate, and it has been almost impossible for parties using it to estimate the amount of fuel displaced. As stated elsewhere, the above figures can only be regarded as the best approximation under the circumstances.

PRODUCTION OF NATURAL GAS IN INDIANA IN 1889, BY COUNTIES.

| COUNTIES. | Value of natural gas supplied and used. | COAL DISPLACED. | | WOOD DISPLACED. | |
|---|---|---|---|---|---|
| | | Tons. | Value. | Tons. | Value. |
| Total | $1,362,472 | 716,461 | $2,002,762 | 44,888 | $72,940 |
| Bartholomew | 35 | 7 | 35 | | |
| Blackford | 88,881 | 59,075 | 240,610 | 600 | 1,200 |
| Dearborn | 50 | 15 | 50 | | |
| Decatur | 11,350 | 4,722 | 18,269 | 463 | 1,130 |
| Dekalb | 2,250 | 750 | 2,250 | | |
| Delaware | 129,415 | 159,348 | 228,762 | 3,340 | 5,100 |
| Grant | 142,859 | 77,009 | 221,655 | 7,500 | 14,800 |
| Hamilton | 17,754 | 11,345 | 27,317 | 1,600 | 4,000 |
| Hancock | 18,484 | 15,000 | 45,606 | 3,350 | 6,787 |
| Henry | 97,909 | 42,592 | 143,276 | 5,020 | 9,745 |
| Howard | 82,055 | 54,352 | 162,101 | 1,760 | 2,135 |
| Jay | 39,700 | 23,000 | 110,000 | 400 | 600 |
| Jennings | 250 | 75 | 300 | | |
| Madison | 592,614 | 198,535 | 556,708 | 18,355 | 22,443 |
| Marion | 10,630 | 3,320 | 10,630 | | |
| Miami | 9,250 | 5,600 | 19,600 | | |
| Randolph | 15,748 | 8,561 | 25,030 | 2,500 | 5,000 |
| Rush | 10,209 | 4,707 | 14,238 | | |
| Shelby | 300 | 80 | 300 | | |
| Tipton | 55,955 | 32,250 | 98,825 | | |
| Wabash | 30,884 | 13,956 | 69,000 | | |
| Washington | 150 | 50 | 150 | | |
| Wayne | 5,740 | 2,112 | 8,050 | | |

## USES.

The reports show that 109,015 heating and cooking fires, 6 iron rolling mills, 11 glass works, 1 gas company, and 439 other industrial establishments consumed natural gas in 1889 in Indiana. No gas is reported as having been used in Carroll and Harrison counties.

### USES TO WHICH NATURAL GAS PRODUCED IN INDIANA IN 1889 WAS PUT.

| COUNTIES. | Fires for cooking and heating. | Iron rolling mills. | Glass works. | Gas companies. | Other industrial establishments. |
|---|---|---|---|---|---|
| Total | 109,015 | 6 | 11 | 1 | 439 |
| Bartholomew | 3 | ........ | ........ | ........ | ........ |
| Blackford | 6,342 | ........ | ........ | ........ | 40 |
| Dearborn | 1 | ........ | ........ | ........ | 1 |
| Decatur | 1,133 | ........ | ........ | ........ | ........ |
| Dekalb | 150 | ........ | ........ | ........ | 1 |
| Delaware | 10,040 | 1 | 2 | ........ | 43 |
| Grant | 9,592 | ........ | 4 | ........ | 90 |
| Hamilton | 2,056 | ........ | ........ | ........ | 10 |
| Hancock | 4,863 | ........ | ........ | ........ | 12 |
| Henry | 7,407 | 5 | ........ | ........ | 19 |
| Howard | 7,520 | ........ | ........ | ........ | 31 |
| Jay | 3,087 | ........ | 1 | ........ | 15 |
| Jennings | 20 | ........ | ........ | ........ | ........ |
| Madison | 41,784 | ........ | 4 | ........ | 85 |
| Marion | 953 | ........ | ........ | ........ | ........ |
| Miami | 940 | ........ | ........ | ........ | 14 |
| Randolph | 1,256 | ........ | ........ | 1 | 7 |
| Rush | 670 | ........ | ........ | ........ | 1 |
| Shelby | ........ | ........ | ........ | ........ | 1 |
| Tipton | 8,207 | ........ | ........ | ........ | 52 |
| Wabash | 2,602 | ........ | ........ | ........ | 16 |
| Washington | 10 | ........ | ........ | ........ | ........ |
| Wayne | 379 | ........ | ........ | ........ | 1 |

## WELLS.

The total number of wells completed in Indiana during 1889, as reported in schedules received, was 307, of which 293 were producing and 14 dry holes. It will be noticed from the table given below that the largest number was drilled in Madison county, which is the most productive natural gas territory in Indiana, it having produced almost one-half of all the gas in the state.

### WELL RECORD, BY COUNTIES.

| COUNTIES. | DRILLING WELLS. | | WELLS COMPLETED IN 1889. | | | NUMBER OF WELLS PRODUCING. | | Number abandoned in 1889. | Total cost of drilling wells, including drive pipe, casing, etc. | DETAIL OF COST. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | December 31, 1888. | December 31, 1889. | Total. | Producing. | Dry holes. | December 31, 1888. | December 31, 1889. | | | Labor. | Materials. |
| Total | 20 | 39 | 307 | 293 | 14 | 287 | 576 | 17 | $431,535 | $34,028 | $39,582 |
| Bartholomew | ........ | ........ | 1 | 1 | ........ | 1 | 2 | ........ | 1,000 | (*a*) | ........ |
| Blackford | ........ | 1 | 26 | 26 | ........ | 4 | 30 | ........ | 33,325 | (*a*) | ........ |
| Carroll | ........ | 1 | 2 | 2 | ........ | ........ | 2 | 2 | 4,223 | 4,011 | 212 |
| Dearborn | ........ | ........ | ........ | ........ | ........ | 6 | 5 | 1 | ........ | ........ | ........ |
| Decatur | ........ | 1 | 10 | 10 | ........ | 29 | 39 | ........ | 11,787 | 1,600 | 1,400 |
| Dekalb | ........ | ........ | 1 | 1 | ........ | 2 | 3 | ........ | 2,250 | (*a*) | ........ |
| Delaware | ........ | 5 | 41 | 41 | ........ | 29 | 70 | ........ | 57,767 | 1,016 | 3,220 |
| Grant | 2 | 1 | 19 | 18 | 1 | 32 | 50 | ........ | 22,870 | (*a*) | ........ |
| Hamilton | 2 | 2 | 7 | 7 | ........ | 15 | 22 | ........ | 11,015 | 2,020 | 3,830 |
| Hancock | 2 | ........ | 15 | 15 | ........ | 7 | 21 | 1 | 26,285 | (*a*) | ........ |
| Harrison | ........ | 1 | 7 | 5 | 2 | ........ | 4 | 1 | 11,007 | 7,500 | 3,507 |
| Henry | 5 | 3 | 24 | 22 | 2 | 15 | 41 | ........ | 37,750 | (*a*) | ........ |
| Howard | ........ | 3 | 21 | 19 | 2 | 22 | 39 | 2 | 31,575 | 4,500 | 11,500 |
| Jay | ........ | 1 | 8 | 8 | ........ | 14 | 20 | 2 | 11,450 | 600 | 400 |
| Jennings | ........ | ........ | 3 | 3 | ........ | ........ | 3 | ........ | 4,500 | (*a*) | ........ |
| Madison | 8 | 11 | 61 | 61 | ........ | 55 | 116 | 6 | 90,350 | 1,600 | 550 |
| Marion | ........ | ........ | ........ | ........ | ........ | 10 | 10 | ........ | ........ | ........ | ........ |
| Miami | ........ | ........ | 2 | 2 | ........ | 3 | 5 | ........ | 2,100 | (*a*) | ........ |
| Randolph | ........ | 1 | 19 | 14 | 5 | 10 | 24 | ........ | 24,275 | 2,981 | 5,445 |
| Rush | ........ | 3 | 14 | 13 | 1 | 7 | 20 | ........ | 16,075 | 5,100 | 4,500 |
| Shelby | ........ | 1 | 1 | 1 | ........ | ........ | 1 | ........ | 900 | (*a*) | ........ |
| Tipton | 1 | 3 | 15 | 15 | ........ | 7 | 22 | ........ | 22,608 | 1,600 | 2,000 |
| Wabash | ........ | ........ | 8 | 7 | 1 | 8 | 14 | 2 | 6,918 | 1,500 | 3,018 |
| Washington | ........ | ........ | ........ | ........ | ........ | 5 | 5 | ........ | ........ | ........ | ........ |
| Wayne | ........ | 1 | 2 | 2 | ........ | 6 | 8 | ........ | 1,505 | (*a*) | ........ |

*a* Contract.

The total number of producing wells in Indiana at the close of 1888 was 287, and 576 at the close of 1889, 17 having been abandoned.

The total cost of completing the 307 wells which were drilled in Indiana during 1889 was $431,535, as reported, $34,028 having been expended for labor and $39,582 for materials, no report having been made of work done by contract.

In the following table is given the number of wells producing in Indiana at the close of December, 1888, and at the close of each month during 1889, together with the number of wells abandoned during 1889:

PRODUCING WELLS.

| MONTHS. | Total number producing. | Total number abandoned. |
|---|---|---|
| 1888. | | |
| December 31 | 287 | 4 |
| 1889. | | |
| January 31 | 316 | |
| February 28 | 330 | 1 |
| March 31 | 344 | 2 |
| April 30 | 358 | 1 |
| May 31 | 371 | 1 |
| June 30 | 399 | |
| July 31 | 426 | |
| August 31 | 451 | |
| September 30 | 472 | 4 |
| October 31 | 501 | |
| November 30 | 535 | 2 |
| December 31 | 576 | 2 |

The following table is a statement of the number of wells completed during each month of 1889 in Indiana also the number of the same that were productive and the number of dry holes:

WELLS COMPLETED IN INDIANA IN 1889.

| MONTHS. | Total number of wells completed in each month. | Number of wells producing. | Number of dry holes. |
|---|---|---|---|
| Total | 307 | 293 | 14 |
| January | 29 | 28 | 1 |
| February | 14 | 14 | |
| March | 18 | 17 | 1 |
| April | 14 | 14 | |
| May | 17 | 15 | 2 |
| June | 24 | 24 | |
| July | 28 | 27 | 1 |
| August | 27 | 25 | 2 |
| September | 29 | 27 | 2 |
| October | 26 | 25 | 1 |
| November | 35 | 34 | 1 |
| December | 46 | 43 | 3 |

## CAPITAL.

The total capital employed in the production of natural gas in Indiana in 1889 was $8,205,813, of which $1,090,218 represented the total value of land and $7,115,595 the value of other property. For the value and credence to be given these figures reference is to be had to the general discussion on the subject of capital in the early part of this report.

## LABOR AND WAGES.

The number of employés engaged in the production, transportation, and distribution of natural gas in 1889 in Indiana was 2,007, who received $341,851 in wages. The amount received per man per year, on the supposition that each man employed worked the whole year, is very small, about $170; but it must be remembered that a great many persons were employed only for a brief period, as in laying pipe and drilling wells. Indeed, the number of persons necessary to be employed the whole time in the natural gas industry is very small, the chief work being in connection with drilling wells and laying pipe line. When this is done the chief labor is over.

## CAPITAL INVESTED IN THE NATURAL GAS INDUSTRY IN INDIANA IN 1889.

| COUNTIES. | Total capital. | NUMBER ACRES OF NATURAL GAS LAND. | | | | VALUE OF PLANT. | | |
|---|---|---|---|---|---|---|---|---|
| | | Total acreage. | Owned. | Leased. | Value. | Land. | Rigs, etc. | Pipe lines. |
| Total | $8, 205, 813 | 77, 493 | 12, 294 | 65, 199 | $1, 090, 218 | $1, 396, 949 | $4, 792, 548 | $926, 098 |
| Bartholomew | 2, 288 | | | | 25 | 1, 598 | 165 | 500 |
| Blackford | 1, 479, 595 | 9, 139 | 137 | 9, 002 | 171, 045 | 40, 575 | 1, 222, 775 | 45, 200 |
| Carroll | 7, 585 | | | | | 4, 223 | 3, 149 | 213 |
| Dearborn | 7, 800 | 60 | | 60 | 325 | 2, 200 | 275 | 5, 000 |
| Decatur | 85, 530 | 387 | 202 | 185 | 7, 805 | 54, 774 | 20, 031 | 2, 920 |
| Dekalb | 28, 000 | 31 | 31 | | 4, 500 | 8, 500 | 5, 000 | 10, 000 |
| Delaware | 716, 123 | 4, 180 | 4, 092 | 88 | 185, 001 | 346, 035 | 176, 408 | 8, 679 |
| Grant | 667, 241 | 7, 939 | 596 | 7, 343 | 47, 020 | 316, 212 | 296, 959 | 7, 050 |
| Hamilton | 97, 170 | 323 | 321 | 2 | 16, 805 | 32, 065 | 46, 300 | 2, 000 |
| Hancock | 131, 660 | 122 | 20 | 102 | 3. 832 | 37, 288 | 51, 290 | 39, 250 |
| Harrison | 15, 500 | 8, 800 | | 8, 800 | 2, 000 | 8, 000 | | 5, 500 |
| Henry | 211, 398 | 838 | 231 | 607 | 47, 975 | 72, 850 | 74, 119 | 16, 454 |
| Howard | 1, 229, 699 | 5, 178 | 162 | 5, 016 | 339, 070 | 106, 040 | 215, 734 | 568, 855 |
| Jay | 235, 400 | 1, 431 | 1 | 1, 430 | 5, 800 | 36, 800 | 150, 900 | 41, 900 |
| Jennings | 7, 000 | | | | 500 | 4, 500 | 2, 000 | |
| Madison | 2, 037, 664 | 22, 176 | 5. 971 | 16, 205 | 54, 150 | 143, 224 | 1, 744, 733 | 95, 557 |
| Marion | 63, 506 | | | | 30, 000 | 13, 506 | | 20, 000 |
| Miami | 59, 500 | 603 | 341 | 262 | 33, 100 | 8, 400 | 13, 000 | 5, 000 |
| Randolph | 85, 773 | 431 | 49 | 382 | 4, 560 | 34, 600 | 38, 340 | 8, 273 |
| Rush | 46, 595 | 138 | 137 | 1 | 1, 695 | 30, 754 | 12, 154 | 1, 992 |
| Shelby | 1, 500 | | | | | 900 | 500 | 100 |
| Tipton | 678, 034 | 9, 713 | 1 | 9, 712 | 84, 780 | 45, 300 | 525, 199 | 22, 755 |
| Wabash | 284, 452 | 6, 000 | | 6, 000 | 50, 000 | 38, 000 | 188, 452 | 8, 000 |
| Washington | 6, 000 | | | | | 6, 000 | | |
| Wayne | 20, 800 | 4 | 2 | 2 | 230 | 4, 605 | 5, 065 | 10, 900 |

## LABOR AND WAGES, BY COUNTIES.

| COUNTIES. | TOTAL. | | FOREMEN OR OVERSEERS. | | MECHANICS. | | LABORERS. | | BOYS UNDER 16 YEARS. | | OFFICE. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Males. | | Females. | |
| | Number. | Wages. | Number. | Wages. | Number. | Wages. | Number. | Wages. | Number. | Wages. | Number. | Wages. | Number. | Wages. |
| Total | 2, 007 | $341, 851 | 153 | $58, 865 | 324 | $97, 091 | 1, 408 | $134, 388 | 2 | $160 | 115 | $49, 287 | 5 | $2, 060 |
| Bartholomew | | | | | | | | | | | | | | |
| Blackford | 120 | 5, 467 | 16 | 488 | 17 | 580 | 79 | 2, 605 | | | 8 | 1, 794 | | |
| Carroll | | | | | | | | | | | | | | |
| Dearborn | | | | | | | | | | | | | | |
| Decatur | 16 | 1, 170 | 3 | 340 | 1 | 90 | 8 | 615 | | | 4 | 125 | | |
| Dekalb | 2 | 2, 000 | 1 | 1, 700 | | | | | | | 1 | 300 | | |
| Delaware | 120 | 13, 565 | 12 | 1, 444 | 22 | 3, 869 | 76 | 5, 982 | | | 9 | 1, 770 | 1 | 500 |
| Grant | 418 | 49, 523 | 6 | 5, 741 | 25 | 9, 072 | 379 | 28, 786 | | | 8 | 5, 924 | | |
| Hamilton | 59 | 3, 316 | 10 | 1, 309 | 9 | 970 | 29 | 490 | | | 11 | 547 | | |
| Hancock | 102 | 4, 467 | 7 | 1, 005 | 4 | 60 | 79 | 2, 567 | | | 12 | 835 | | |
| Harrison | | | | | | | | | | | | | | |
| Henry | 92 | 4, 920 | 13 | 1, 124 | 6 | 290 | 71 | 3, 098 | | | 2 | 408 | | |
| Howard | 159 | 36, 636 | 7 | 4, 130 | 13 | 3, 816 | 125 | 20, 490 | 2 | 160 | 10 | 7, 320 | 2 | 720 |
| Jay | 45 | 7, 913 | 5 | 1, 778 | 5 | 1, 390 | 30 | 2, 145 | | | 5 | 2, 600 | | |
| Jennings | 6 | 600 | 2 | 250 | | | 4 | 350 | | | | | | |
| Madison | 219 | 90, 203 | 24 | 12, 867 | 68 | 40, 186 | 102 | 15, 129 | | | 24 | 21, 541 | 1 | 480 |
| Marion | | | | | | | | | | | | | | |
| Miami | 26 | 3, 925 | 4 | 860 | 7 | 1, 560 | 14 | 1, 105 | | | 1 | 400 | | |
| Randolph | 68 | 3, 685 | 3 | 820 | 21 | 1, 920 | 40 | 475 | | | 3 | 110 | 1 | 360 |
| Rush | 57 | 4, 843 | 3 | 160 | 17 | 3, 560 | 29 | 825 | | | 8 | 298 | | |
| Shelby | | | | | | | | | | | | | | |
| Tipton | 456 | 100, 451 | 33 | 21, 909 | 102 | 26, 524 | 316 | 48, 646 | | | 5 | 3, 372 | | |
| Wabash | 38 | 8, 477 | 3 | 2, 700 | 6 | 3, 004 | 27 | 1, 080 | | | 2 | 1, 693 | | |
| Washington | | | | | | | | | | | | | | |
| Wayne | 4 | 690 | 1 | 240 | 1 | 200 | | | | | 2 | 250 | | |

In the following table is a more detailed classification of labor employed in Indiana in the natural gas industry in 1889 than that given in the preceding one:

CLASSIFIED WAGES IN INDIANA, BY COUNTIES.

| CLASS OF LABOR. | Total. | BLACKFORD. | | DECATUR. | | DEKALB. | |
|---|---|---|---|---|---|---|---|
| | | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. |
| Total | 2,007 | 120 | | 16 | | 2 | |
| Treasurers | 1 | | | | | | |
| Bookkeepers | 80 | 2 | $38.33⅓ per month | 4 | $50 per month | 1 | |
| Clerks, male | 41 | 6 | | | | | |
| Superintendents | 29 | | | | | | |
| Foremen or overseers | 121 | 16 | $55 to $60 per month | 3 | $3 per day | 1 | |
| Inspectors | 5 | | | | | | |
| Station agents | 10 | | | | | | |
| Engineers | 6 | | | | | | |
| Plumbers or fitters | 160 | | | 1 | $3 per day | | |
| Drillers | 38 | | | | | | |
| Carpenters | 5 | | | | | | |
| Teamsters | 10 | | | | | | |
| Linemen | 33 | | | | | | |
| Mechanics | 92 | 17 | $1.50 per day | | | | |
| Laborers | 1,374 | 79 | | 8 | $1.25 to $1.50 per day | | |
| Boys under 16 years | 2 | | | | | | |

| CLASS OF LABOR. | DELAWARE. | | GRANT. | | HAMILTON. | |
|---|---|---|---|---|---|---|
| | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. |
| Total | 120 | | 418 | | 59 | |
| Treasurers | | | | | | |
| Bookkeepers | 2 | $3 per day | 5 | $41 to $147 per month | 11 | $3.50 per day. |
| Clerks, male | 5 | $1.50 to $2 per day | 2 | $2 per day | | |
| Superintendents | 5 | $1.50 to $5 per day | 3 | $75 to $100 per month | | |
| Foremen or overseers | 6 | $2 to $2.75 per day | 4 | $2 per day | 10 | $1 per day. |
| Inspectors | | | | | | |
| Station agents | | | | | | |
| Engineers | 2 | $3.50 per day | 1 | $200 per month | | |
| Plumbers or fitters | 7 | $1.25 to $2.50 | | | | |
| Drillers | 9 | $1,236 (*a*) | 4 | $3.50 per day | | |
| Carpenters | 3 | $1.50 to $2.50 per day | | | | |
| Teamsters | | | | | | |
| Linemen | 4 | $1.50 per day | | | | |
| Mechanics | 6 | $1 to $3.50 per day | 21 | $2 to $3.50 per day | 9 | $1.50 to $3 per day. |
| Laborers | 71 | $1 to $2.50 per day | 378 | $1 to $2 per day | 29 | $1 to $1.25 per day. |
| Boys under 16 years | | | | | | |

| CLASS OF LABOR. | HANCOCK. | | HENRY. | | HOWARD. | |
|---|---|---|---|---|---|---|
| | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. |
| Total | 102 | | 92 | | 159 | |
| Treasurers | | | | | | |
| Bookkeepers | 12 | $2 per day | 2 | $2 per day | 11 | $2.50 per day. |
| Clerks, male | | | | | | |
| Superintendents | | | | | | |
| Foremen or overseers | 7 | $1.50 to $2 per day | 13 | $1.50 to $2.50 per day | 8 | $1 to $3.50 per day. |
| Inspectors | | | | | | |
| Station agents | | | | | | |
| Engineers | | | | | | |
| Plumbers or fitters | | | | | | |
| Drillers | | | | | | |
| Carpenters | | | | | | |
| Teamsters | | | | | | |
| Linemen | | | | | | |
| Mechanics | 4 | $2 to $2.50 per day | 6 | $1.25 to $2 per day | 13 | $1.50 to $1.75 per day. |
| Laborers | 79 | $1.25 to $1.50 per day | 71 | $1 to $2 per day | 125 | $1.25 to $1.50 per day. |
| Boys under 16 years | | | | | 2 | $0.38 per day. |

*a* Contract.

CLASSIFIED WAGES IN INDIANA, BY COUNTIES—Continued.

| CLASS OF LABOR. | JAY. | | JENNINGS. | | MADISON. | |
|---|---|---|---|---|---|---|
| | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. |
| Total | 45 | | 6 | | 219 | |
| Treasurers | | | | | | |
| Bookkeepers | 5 | $50 per month | | | 9 | $118 to $200 per month. |
| Clerks, male | | | | | 26 | $25 to $250 per month. |
| Superintendents | 1 | $3 per day | | | 12 | $2 per day. |
| Foremen or overseers | 4 | $2 to $3.50 per day | 2 | $2.50 per day | 11 | $2 to $3 per day. |
| Inspectors | | | | | 5 | |
| Station agents | | | | | 10 | |
| Engineers | | | | | | |
| Plumbers or fitters | 3 | $1.25 to $2 per day | | | 22 | $1.50 to $2.50 per day |
| Drillers | | | | | | |
| Carpenters | 1 | $1.50 per day | | | 1 | $2.50 per day. |
| Teamsters | | | | | | |
| Linemen | | | | | 10 | |
| Mechanics | | | | | 1 | |
| Laborers | 31 | $1 to $1.75 per day | 4 | $1.25 per day | 112 | |
| Boys under 16 years | | | | | | |

| CLASS OF LABOR. | MIAMI. | | RANDOLPH. | | RUSH. | |
|---|---|---|---|---|---|---|
| | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. |
| Total | 26 | | 68 | | 57 | |
| Treasurers | | | | | | |
| Bookkeepers | 1 | $33.33⅓ per month | 4 | $30 per month | 6 | $2 to $3 per day. |
| Clerks, male | | | | | 2 | $1 per day. |
| Superintendents | | | | | 1 | $2 per day. |
| Foremen or overseers | 4 | $3.33⅓ per day | 3 | $1.25 to $4 per day | | |
| Inspectors | | | | | | |
| Station agents | | | | | | |
| Engineers | | | | | 3 | $1.50 to $2 per day. |
| Plumbers or fitters | | | | | | |
| Drillers | | | 2 | $2 per day | 12 | $3 to $4 per day. |
| Carpenters | | | | | | |
| Teamsters | | | | | | |
| Linemen | | | 19 | $1.25 to $1.37 per day | | |
| Mechanics | 8 | $1.25 to $2.66⅔ per day | | | 4 | $1.50 to $4.50 per day. |
| Laborers | 13 | $1.50 to $2 per day | 40 | $1.25 per day | 29 | $1.25 per day. |
| Boys under 16 years | | | | | | |

| CLASS OF LABOR. | TIPTON. | | WABASH. | | WAYNE. | |
|---|---|---|---|---|---|---|
| | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. |
| Total | 456 | | 38 | | 4 | |
| Treasurers | | | | | 1 | |
| Bookkeepers | 2 | $75 to $100 per month | 2 | $70 to $105 per month | 1 | |
| Clerks, male | | | | | | |
| Superintendents | 6 | $3 per day | 1 | $125 per month | | |
| Foremen or overseers | 26 | $2.25 per day | 2 | $25 to $75 per month | 1 | $20 per month. |
| Inspectors | | | | | | |
| Station agents | | | | | | |
| Engineers | | | | | | |
| Plumbers or fitters | 127 | $2 per day | | | | |
| Drillers | 7 | $2.83 per day | 4 | $3 per day | | |
| Carpenters | | | | | | |
| Teamsters | 10 | $3 per day | | | | |
| Linemen | | | | | | |
| Mechanics | | | 2 | $2.50 per day | 1 | $2 per day. |
| Laborers | 278 | $1.25 per day | 27 | $1.50 per day | | |
| Boys under 16 years | | | | | | |

### MATERIALS USED.

The total expenditure for materials in the production and distribution of natural gas in Indiana during 1889 was $1,921,072, of which $3,800 was spent in building rigs, $42,710 in drilling wells, $38,712 in operating, shutting in, and caring for wells, $1,761,203 in pipe lines, $40,190 in fitting, $10,275 for torpedoes, and $24,182 for all other materials.

The amount of wages paid in Indiana in connection with the natural gas industry in 1889 was $341,851, and the amount paid for materials $1,921,072, making a total of $2,262,923. The value of natural gas used in Indiana in 1889, measured by fuel displacement as given above, was $2,075,702. This would indicate a loss of $187,221 as measured by fuel displacement, and $900,451 as measured by the value of natural gas supplied. It is probable that, taking the whole operations of the state together, the loss was as great as this, but was more than compensated to the state by the bringing in of new industries.

### TOTAL EXPENDITURES FOR MATERIALS DURING 1889, BY COUNTIES.

| COUNTIES. | Total. | Building rigs. | Drilling wells. | Operating, shutting in, and caring for wells. | Pipe, couplings, etc., in building and repairing pipe line. | Used in fitting. | TORPEDOES. |  | All other materials. |
|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  | Number. | Value. |  |
| Total | $1,921,072 | $3,800 | $42,710 | $38,712 | $1,761,203 | $40,190 | 82 | $10,275 | $24,182 |
| Bartholomew | 98 |  |  | 98 |  |  |  |  |  |
| Blackford | 1,212,381 |  |  |  | 1,210,506 | 1,000 | 3 | 375 | 500 |
| Carroll | 462 |  |  |  |  |  | 1 | 250 | 212 |
| Dearborn | 130 |  |  |  |  |  | 1 | 130 |  |
| Decatur | 11,861 | 750 | 850 | 1,975 | 2,211 | 625 | 13 | 1,790 | 3,660 |
| Dekalb | 120 |  |  |  |  |  | 1 | 120 |  |
| Delaware | 69,667 | 250 | 23,800 | 3,132 | 29,451 | 4,793 | 7 | 917 | 7,324 |
| Grant | 55,597 |  |  | 485 | 48,200 | 6,112 |  |  | 800 |
| Hamilton | 11,072 | 300 | 2,100 | 1,225 | 7,222 | 200 |  |  | 25 |
| Hancock | 33,726 |  | 650 | 225 | 31,871 | 275 | 4 | 505 | 200 |
| Harrison | 100 |  |  |  |  |  | 2 | 100 |  |
| Henry | 38,303 |  |  |  | 33,778 |  | 7 | 825 | 3,700 |
| Howard | 52,969 | 1,650 | 1,500 | 18,663 | 27,416 | 2,990 | 6 | 750 |  |
| Jay | 13,660 | 100 | 600 | 500 | 8,700 | 3,250 | 5 | 510 |  |
| Jennings | 125 |  |  |  |  |  | 1 | 125 |  |
| Madison | 345,041 |  | 1,000 | 3,867 | 324,393 | 15,155 | 1 | 100 | 526 |
| Miami | 13,750 |  |  | 150 | 13,000 | 600 |  |  |  |
| Randolph | 24,781 |  | 1,675 | 5,947 | 14,859 |  | 15 | 2,275 | 25 |
| Rush | 8,359 |  |  | 1,845 | 4,469 |  | 10 | 1,045 | 1,000 |
| Shelby | 50 |  |  |  |  |  | 1 | 50 |  |
| Tipton | 14,677 |  |  | 100 | 3,462 | 5,015 |  |  | 6,100 |
| Wabash | 13,310 | 750 | 10,535 | 500 | 1,200 | 75 | 2 | 150 | 100 |
| Wayne | 833 |  |  |  | 465 | 100 | 2 | 258 | 10 |

### STATISTICS OF THE PRODUCTION OF NATURAL GAS IN INDIANA IN 1889.

Below is a condensed statement of the figures regarding the development, production, and consumption of natural gas in Indiana in 1889:

|  |  |
|---|---|
| Total amount received for natural gas produced in 1889 | $1,362,472 |
| Coal displaced (tons of 2,000 pounds) | 716,461 |
| Value of same | $2,002,762 |
| Wood displaced (cords) | 44,888 |
| Value of same | $72,940 |

### USES.

|  |  |
|---|---|
| Total number of fires for cooking and heating | 109,015 |
| Total number of iron rolling mills supplied | 6 |
| Total number of glass works supplied | 11 |
| Total number of gas companies supplied | 1 |
| Total number of other industrial establishments supplied | 439 |

### WELLS.

| | |
|---|---|
| Number of wells drilling December 31, 1888 | 20 |
| Number of wells drilling December 31, 1889 | 39 |
| Number of wells completed in 1889 | 307 |
| Producing wells completed in 1889 | 293 |
| Dry holes completed in 1889 | 14 |
| Number of wells producing December 31, 1888 | 287 |
| Number of wells producing December 31, 1889 | 576 |
| Number of wells abandoned in 1889 | 17 |
| Total cost of drilling wells, including drive pipes, casing, etc | $431, 535 |
| Labor | $34, 028 |
| Materials | $39, 582 |

### CAPITAL.

| | |
|---|---|
| Number of acres of natural gas land: | |
| Owned | 12, 294 |
| Leased | 65, 199 |
| Total | 77, 493 |
| Value of land | $1, 090, 218 |
| Value of rigs, wells, etc | 1, 396, 949 |
| Value of pipe lines | 4, 792, 548 |
| Value of other property and improvements | 926, 098 |
| Total capital invested in lands, wells, etc., and used in the business | 8, 205, 813 |

### LABOR AND WAGES.

| | |
|---|---|
| Number of foremen or overseers | 153 |
| Number of mechanics | 324 |
| Number of laborers | 1, 408 |
| Number of boys under 16 years | 2 |
| Number of office force, males | 115 |
| Number of office force, females | 5 |
| Total number of employés | 2, 007 |
| Wages paid foremen or overseers | $58, 865 |
| Wages paid mechanics | 97, 091 |
| Wages paid laborers | 134, 388 |
| Wages paid boys under 16 years | 160 |
| Wages paid office force, males | 49, 287 |
| Wages paid office force, females | 2, 060 |
| Total wages paid employés | 341, 851 |

### EXPENDITURES FOR MATERIALS, ETC.

| | |
|---|---|
| Total amount expended in building rigs | $3, 800 |
| Total amount expended in drilling wells | 42, 710 |
| Total amount expended in operating, shutting in, and caring for wells | 38, 712 |
| Total amount expended in pipe, couplings, etc., in building and repairing pipe lines | 1, 761, 203 |
| Total amount expended in fitting | 40, 190 |
| Total amount expended for torpedoes | 10, 275 |
| Total amount expended for all other materials | 24, 182 |
| Total expenditures for materials | 1, 921, 072 |

## NEW YORK.

The first use of natural gas in this state in an economic way was, as is stated under "History of the use of natural gas in the United States", on page 507, for lighting the streets of Fredonia, New York. Gas was obtained and used for this purpose as early as 1821.

In 1823 Professor Eaton measured the product of a gas spring immediately west of the village of Vernon, Oneida county. Dr. P. Hays, in the New York Medical and Physical Journal, some time prior to 1842 gives an account of inflammable springs in Oneida county, and in 1839 Professor Hall, in a New York geological report, describes the occurrence of gas at Manchester, on the east side of Onondaga lake, the gas issuing from clefts in the rock. At Gasport, on the Erie canal, in Niagara county, about 6 miles east of Lockport, Professor Eaton prior to 1842 describes the occurrence of gas springs.

Along the shore of Lake Erie, in the vicinity of Westfield, Chautauqua county, gas was found and utilized as early as 1826. The gas issued along the bed of a creek in a small ravine about 1.5 miles north of the village, 1 mile east of the harbor, and not over 900 feet from the lake shore. In a report published in 1856 regarding this well it is said:

> The flow is perfectly uniform during summer and winter, and the gas is equal if not superior to the best quality of manufactured gas, burning with a bright, pleasant flame, free from odor or smoke. An application to the government of the United States for a contract to supply the lighthouse at the harbor called Barcelona with this gas was accepted, and in 1828 or 1829 the works necessary for carrying out the project were erected.
>
> The means used for collecting and conducting the gas to the lighthouse (over 1 mile from the spring) were of the rudest and most imperfect kind, the gasometer being formed of the half of a fish barrel inverted over a portion of the spring and the mains consisting of small pump logs running to the base of the lighthouse, from which the gas was conveyed to the summit by an ordinary lead pipe, supplying, without the aid of accumulation or artificial pressure or other mechanical means save the force of the natural flow, nearly double the amount of gas required for the consumption of 140 6-foot burners, furnishing a bright, steady, unfailing light for lighthouse purposes, a light pronounced by all to be the best light on Lake Erie, for a period of over 26 years.
>
> The only improvement that has ever been made in these works has been that of substituting a lead pipe three-quarters of an inch in diameter when the logs had become so much decayed as to be unfit for use. The gasometer remains the same.

It is further reported that a company was formed for utilizing this gas. Pipes were laid and 3,000 gas-burners used. This gas is still used in a very small way.

The most important gas district in New York, in fact the only one which has been drawn upon for the distribution of gas generally to consumers, is that in Allegany county. This area corresponds closely to the Allegany oil district. While many of the oil wells of this district produce gas in greater or less amounts, the principal gas wells have been found along the fringe and a little beyond the boundary of the oil-producing territory. At one time in this district of the 102 wells owned by the Empire Gas and Fuel Company, limited, 73 produced oil, 4 oil and gas combined, and 25 gas alone.

The geological horizon of the Allegany oil and gas sand, or what is commonly and locally known as the Richburg sand, is without doubt the same as that of the main producing oil and gas sand of the Bradford region. The top of this sand is undulating, and in many localities has excessive dips, in one case as much as 160 feet to the mile, while the greatest observed dip in this sand in the Bradford region proper is 18 feet.

The character of the sand in Allegany is such that, while beyond doubt the supply of gas will be gradually exhausted, no sudden cessation of production will occur. The decline will be more gradual than that of other gas districts which draw their gas supplies from coarser and more open gas rocks. One report from a company producing a large amount of gas states that the decline in pressure in the last 6 years has been 75 per cent and very gradual. In the vicinity of Ceres the wells lost 33.33 per cent in pressure in 2 years. At wells in the vicinity of Wellsville and Bolivar 2 initial pressures are reported, 350 and 100 pounds. In a year the pressure of the former was reduced to 200 pounds and of the weaker to 80 pounds. The depth of gas wells in this district is from 1,000 to 1,500 feet.

Some of the gas from the Allegany district is piped to Buffalo, but most of it is used locally. A large amount of it is consumed in drilling oil wells and at the pipe-line stations in pumping oil. In drilling wells it is customary to pay so much per foot drilled for the supply of gas used as fuel under the boilers. From 8 to 10 cents a foot seems to be the average price for a 1,450-foot well, which would be $116.

Adjoining Allegany county on the east is Steuben and on the west Cattaraugus, while directly west of Cattaraugus is Chautauqua. All of these counties are on the Pennsylvania line. The portion of New York due north of Cattaraugus county and between it and Lake Ontario is covered by Erie and Niagara counties. In all of these counties some gas has been found. Steuben county produces a little shallow gas, but the district gives no indications that it will ever become a large producer.

The Fredonia wells are in Chautauqua county, and are of but little importance except historically. The production of gas is only about 4,500 cubic feet a day.

Little or no gas is produced in Cattaraugus county, the gas used at Salamanca being supplied by the United Natural Gas Company, whose supply comes from Allegany county, New York, and McKean, Potter, and Butler counties, Pennsylvania. The displacement of coal by this gas in 1889 was 11,650 tons, worth $150,000.

In Erie county a number of gas wells were drilled in 1889, but few were able to supply even the demands of their owners for fuel.

The chief source of supply of gas for Buffalo, as also for Cattaraugus county, is from the lines of the United Natural Gas Company, which draw their supplies largely from Pennsylvania.

At North Tonawanda, in Niagara county, a local company was formed in 1888 for the purpose of ascertaining if gas could be found in paying quantities. A well was drilled to a depth of 3,009 feet at North Tonawanda which produced a small amount. Another well was drilled to a depth of 565 feet, the gas from which was piped to the proprietor's residence and used by him for heating purposes. A third well was drilled to 575 feet, the production of which was also temporarily ample for a residence. None of the ventures proving sufficiently productive, further developments were discontinued.

At Sandy Creek, Oswego county, a local company drilled 2 wells in 1889, consumers being supplied in December, 1889, for the first time.

At West Bloomfield, Ontario county, 14 wells were drilled in 1889. These wells range from 400 to 500 feet in depth and terminate in Hamilton shale. During 1890 one of the oldest wells was drilled through to 800 feet, when the pressure was increased to 300 pounds. The gas obtained is a sulphur gas, with no indications of petroleum. The initial pressure of all wells, excepting 2, was less than 25 pounds. In one case it was 118 and in another 212 pounds to the square inch. It was contemplated to continue drilling the 1890 well deeper, with the hope of finding a still more productive sand.

### PRODUCTION OF NATURAL GAS IN NEW YORK IN 1889.

In the following table will be found a statement as to the total production of natural gas in New York in 1889. The reported value of the gas produced in this state, counting as value the amount of money received for it, was $204,325. The amount of coal displaced, however, was 130,159 tons, valued at $530,026. This latter is therefore regarded as the value of the gas consumed in New York in 1889. As stated elsewhere, the chief production of natural gas in New York was in Allegany county, the value of gas produced in this county, measured by fuel displacement, being $504,288, the value of gas produced in all the other counties of the state being but $25,738.

Considerable of the natural gas produced in Allegany county was used in drilling oil and other gas wells, and another large amount at oil pumping stations. This is not reported in the total of fuel displacement, but its value is included in the amount estimated as used in pumping oil and drilling and operating wells given under the general discussion of the question of "Production in the United States".

PRODUCTION OF NATURAL GAS IN NEW YORK IN 1889, BY COUNTIES.

| COUNTIES. | Total value. | COAL DISPLACED. | |
|---|---|---|---|
| | | Tons. | Value. |
| Total | $204,325 | 130,159 | $530,026 |
| Allegany | 185,261 | 124,907 | 504,288 |
| Chautauqua | 2,500 | | |
| Erie | 7,179 | 2,178 | 11,519 |
| Niagara | 450 | 124 | 619 |
| Ontario | 6,186 | 1,800 | 8,100 |
| Oswego | 500 | 150 | 750 |
| Steuben | 2,249 | 1,000 | 4,750 |

### USES.

The uses to which natural gas produced in New York in 1889 was put are shown in the following table. From this it will appear that most of the gas consumed was in heating and cooking fires; no iron mills or glass works were supplied, and only 11 industrial establishments.

USES TO WHICH NATURAL GAS PRODUCED IN NEW YORK IN 1889 WAS PUT.

| COUNTIES. | Fires for cooking and heating. | Industrial establishments. |
|---|---|---|
| Total | 4,362 | 11 |
| Allegany | 3,392 | 5 |
| Chautauqua | 30 | |
| Erie | 240 | 2 |
| Niagara | 12 | 1 |
| Ontario | 288 | 1 |
| Oswego | 150 | 2 |
| Steuben | 250 | |

### WELLS.

The total number of wells in New York producing natural gas at the close of 1889 was 119, as compared with 69 at the beginning of the year. The number of wells completed in 1889 was 65, of which 55 were producing and 10 were dry holes. During the year 3 wells were abandoned. The total cost of drilling these wells, as reported, was $74,752. The amount paid by the producers for labor in drilling wells, not including any sums paid to contractors, who drilled by the foot, was $23,604. The amount paid for materials under the same circumstances was $14,256.

WELL RECORD, BY COUNTIES.

| COUNTIES. | DRILLING WELLS. | | WELLS COMPLETED IN 1889. | | | NUMBER OF WELLS PRODUCING. | | Number abandoned in 1889. | Total cost of drilling wells, including drill pipe, casing, etc. | DETAIL OF COST. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | December 31, 1888. | December 31, 1889. | Total. | Producing. | Dry holes. | December 31, 1888. | December 31, 1889. | | | Labor. | Materials. |
| Total | *a*5 | 12 | 65 | 55 | 10 | 69 | 119 | 3 | $74, 752 | $23, 604 | $14, 256 |
| Allegany | | 1 | 18 | 16 | 2 | 51 | 63 | 1 | 16, 809 | 3, 600 | 5, 517 |
| Chautauqua | | | | | | 5 | 5 | | | | |
| Erie | | 9 | 16 | 16 | | 6 | 22 | 1 | 28, 600 | 2, 500 | 500 |
| Fulton | | 1 | 1 | 1 | | | 1 | | | | |
| Lewis | | | 1 | | 1 | | | | 1, 550 | 1, 050 | 500 |
| Niagara | | | 4 | 4 | | 1 | 5 | | 11, 200 | 6, 600 | 1, 000 |
| Ontario | | | 14 | 12 | 2 | 6 | 18 | | 4, 812 | 2, 154 | 2, 658 |
| Oswego | | | 2 | 2 | | | 2 | | 3, 000 | 2, 200 | 800 |
| Steuben | | 1 | 9 | 4 | 5 | | 3 | 1 | 8, 781 | 5, 500 | 3, 281 |

*a* Data by counties not obtainable.

In the following table is shown the number of wells completed in each month during 1889, together with the number of dry holes and the number of completed wells that were producing:

WELLS COMPLETED IN NEW YORK IN 1889.

| MONTHS. | Total number of wells completed in each month. | Number of dry holes. | Number of wells producing. |
|---|---|---|---|
| Total | 65 | 10 | 55 |
| January | 5 | | 5 |
| February | 2 | 1 | 1 |
| March | 4 | 1 | 3 |
| April | 4 | 3 | 1 |
| May | 2 | 1 | 1 |
| June | 5 | 1 | 4 |
| July | 11 | 1 | 10 |
| August | 5 | 1 | 4 |
| September | 8 | 1 | 7 |
| October | 3 | | 3 |
| November | 5 | | 5 |
| December | 11 | | 11 |

In the following table is given the number of producing wells at the close of each month from the close of 1888 to the close of 1889. This number gradually increased from the close of 1888, when it was 69, to the close of 1889, when it was 119. The table also shows the total number of wells abandoned, which was 3.

WELLS PRODUCING IN NEW YORK IN 1889.

| MONTHS. | Total number producing. | Total number abandoned. |
|---|---|---|
| 1888. | | |
| December 31 | 69 | 1 |
| 1889. | | |
| January 31 | 74 | 1 |
| February 28 | 73 | 1 |
| March 31 | 76 | |
| April 30 | 77 | |
| May 31 | 75 | |
| June 30 | 79 | |
| July 31 | 89 | |
| August 31 | 93 | |
| September 30 | 100 | |
| October 31 | 103 | |
| November 30 | 108 | |
| December 31 | 119 | |

### CAPITAL.

The total capital employed in the development, production, and transportation of natural gas in the state of New York in 1889 was $1,162,429. Of this amount $298,120 represented the value of the land and $864,309 the value of all other property.

The largest value of land in any one county it will be noted is in Ontario, where it is given as $132,000, while the value of land in Allegany county, where the production of gas was very much greater, is given as $68,720. This comes from the fact that the value of the 18 producing wells that belonged to the single company operating in Ontario county is included in the value of the lease. Assuming that these wells were worth $2,500 apiece, the total value of land in this state would be reduced by $45,000 and the value of rigs, wells, etc., increased by the same amount, though there would be no difference in the totals. With this change in the reported values of the land the same remark that has been made elsewhere regarding it will apply here. This value is very much underestimated, that given being probably only the amount of money paid for the lease and not the worth of the land as producing territory.

The total value of the rigs, wells, etc., as given in the schedules received, was $169,753, to which should be added $45,000, assumed as the value of wells in Ontario county, which is included in the column of the value of land. This would make the total value of wells, rigs, etc., $214,753. As there were 119 wells in this state at the close of 1889, the value of each well would be $1,805. While this is probably an underestimate, it is nevertheless true that the average value of gas wells is not so great as that of oil wells. The reasons will be obvious. Among other reasons, gas is a commodity that is used as produced; it can not be stored; it is an expensive product to transport to points of consumption, and its value at point of consumption is not great, while the life of the well, its production, decreases very rapidly and the territory is sooner exhausted than an oil territory of equal extent. The total value of pipe lines in this state, including rights of way, was $580,519. As there were 1,783,069 feet of pipe line in this state at the close of 1889, it would make the value per foot laid, including royalty, only 33 cents, which is evidently an underestimate, unless the value of the pipe in the ground is regarded as very much less than the actual cost. It is probable that this is the view taken.

CAPITAL INVESTED IN THE NATURAL GAS INDUSTRY IN NEW YORK IN 1889.

| COUNTIES. | Total capital. | NUMBER OF ACRES OF NATURAL GAS LAND. | | | | VALUE OF PLANT. | | |
|---|---|---|---|---|---|---|---|---|
| | | Total acreage. | Owned. | Leased. | Value. | Rigs, wells, etc. | Pipe lines. | Other property. |
| Total | $1,162,429 | 49,870 | 533 | 49,337 | $298,120 | $169,753 | $580,519 | $114,037 |
| Allegany | 713,085 | 3,688 | 15 | 3,673 | 68,720 | 64,903 | 475,925 | 103,537 |
| Chautauqua | 17,500 | .......... | .......... | .......... | 1,200 | 11,300 | 3,000 | 2,000 |
| Erie | 169,600 | 371 | 371 | .......... | 51,300 | 56,800 | 56,500 | 5,000 |
| Fulton | 9,500 | 50 | 50 | .......... | 500 | 7,950 | 50 | 1,000 |
| Lewis | 5,000 | 4,864 | .......... | 4,864 | 4,400 | 600 | .......... | .......... |
| Niagara | 19,650 | 300 | .......... | 300 | 12,000 | 7,200 | 450 | .......... |
| Ontario | 154,594 | 25,097 | 97 | 25,000 | 132,000 | .......... | 22,594 | .......... |
| Oswego | 20,500 | 5,000 | .......... | 5,000 | 13,000 | 3,000 | 4,000 | 500 |
| Steuben | 53,000 | 10,500 | .......... | 10,500 | 15,000 | 18,000 | 18,000 | 2,000 |

### LABOR AND WAGES.

The total number of employés engaged in the natural gas industry in New York in 1889 was 357, to whom $34,235 was paid in wages. The remarks made heretofore regarding the value of these statistics must be borne in mind when studying them. A great deal of labor employed in contract work is not included in this table, this labor being that employed directly by the producers of natural gas and paid by them.

LABOR AND WAGES, BY COUNTIES.

| COUNTIES. | TOTAL. | | FOREMEN OR OVERSEERS. | | MECHANICS. | | LABORERS. | | OFFICE. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Males. | | Females. | |
| | Number. | Wages. | Number. | Wages. | Number. | Wages. | Number. | Wages. | Number. | Wages. | Number. | Wages. |
| Total | 357 | $34,235 | 11 | $4,152 | 37 | $4,443 | 296 | $17,687 | 12 | $7,868 | 1 | $85 |
| Allegany | 116 | 18,498 | 4 | 2,730 | 14 | 1,082 | 92 | 10,054 | 6 | 4,632 | .......... | .......... |
| Chautauqua | 2 | 1,096 | .......... | .......... | .......... | .......... | 2 | 1,096 | .......... | .......... | .......... | .......... |
| Erie | 66 | 3,309 | 1 | 150 | 4 | 600 | 60 | 2,439 | 1 | 120 | .......... | .......... |
| Lewis | 8 | 3,322 | 1 | 50 | 4 | 1,001 | .......... | .......... | 2 | 2,186 | 1 | 85 |
| Ontario | 62 | 3,460 | 1 | 772 | 2 | 110 | 58 | 2,098 | 1 | 480 | .......... | .......... |
| Oswego | 76 | 2,050 | 3 | 300 | 12 | 1,200 | 60 | 500 | 1 | 50 | .......... | .......... |
| Steuben | 27 | 2,500 | 1 | 150 | 1 | 450 | 24 | 1,500 | 1 | 400 | .......... | .......... |

In the following table will be found a statement of the number of employés, range of wages, etc., giving the classes of labor more in detail:

CLASSIFIED WAGES IN NEW YORK, BY COUNTIES.

| CLASS OF LABOR. | Total. | ALLEGANY. | | CHAUTAUQUA. | | ERIE. | |
|---|---|---|---|---|---|---|---|
| | | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. |
| Total | 357 | 116 | | 2 | | 66 | |
| Secretaries | 7 | 2 | $75 to $90 per month | | | | |
| Clerks, male | 4 | 3 | $55 per month | | | 1 | $60 per month. |
| Clerks, female | 1 | | | | | | |
| Telegraph operators | 3 | 3 | $2 per day | | | | |
| Superintendents | 5 | 5 | $2 to $3.25 per day | | | | |
| Foremen or overseers | 10 | 3 | $50 to $75 per month | | | 1 | $75 per month. |
| Agents | 1 | 1 | $90 per month | | | | |
| Engineers | 2 | | | | | | |
| Drillers | 10 | | | | | | |
| Men at well | 3 | | | | | | |
| Teamsters | 13 | | | | | | |
| Linemen | 3 | 3 | $2 per day | | | | |
| Watchmen | 5 | 5 | $2 per day | | | | |
| Mechanics | 33 | 14 | $3 to $3.75 per day | | | 4 | $2.50 per day. |
| Laborers | 257 | 77 | $1.50 to $1.65 per day | 2 | $1.75 per day | 60 | $1.50 per day. |

| CLASS OF LABOR. | LEWIS. | | ONTARIO. | | OSWEGO. | | STEUBEN. | |
|---|---|---|---|---|---|---|---|---|
| | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. | Number. | Range of wages. |
| Total | 8 | | 62 | | 76 | | 27 | |
| Secretaries | 2 | $95 per month | 1 | $40 per month | 1 | $2.50 per day | 1 | $33.33⅓ per month. |
| Clerks, male | | | | | | | | |
| Clerks, female | 1 | $45.50 per month | | | | | | |
| Telegraph operators | | | | | | | | |
| Superintendents | | | | | | | | |
| Foremen or overseers | 1 | $1 per day | 1 | $65 per month | 3 | $1 per day | 1 | $50 per month. |
| Agents | | | | | | | | |
| Engineers | | | 2 | $3.25 per day | | | | |
| Drillers | 2 | $3.75 per day | 8 | $2.60 per day | | | | |
| Men at well | 2 | $2.25 per day | 1 | $30 per month | | | | |
| Teamsters | | | 13 | $3.25 per day | | | | |
| Linemen | | | | | | | | |
| Watchmen | | | | | | | | |
| Mechanics | | | 2 | $2.25 per day | 12 | $2 per day | 1 | $37.50 per month. |
| Laborers | | | 34 | $1.50 per day | 60 | $1.50 per day | 24 | $1.50 per day. |

The total expenditures during 1889 for material in development of gas territory and production and transportation of natural gas were $511,141. This is very nearly equal to the total value of the gas, measured by the coal displaced, and two and a half times the total value of production measured by the amount of money received. The explanation of this apparent discrepancy is that in this statement of total expenditures for materials is included the expenditure at a number of wells drilled during the year that were not producers, and also a large amount spent in laying pipe lines, all of which is charged to expense for materials in 1889, on which returns will be expected for a number of years.

TOTAL EXPENDITURES FOR MATERIALS DURING 1889, BY COUNTIES.

| COUNTIES. | Total. | Building rigs. | Drilling wells. | Operating, shutting in, and caring for wells. | Pipe, couplings, etc., in building and repairing pipe line. | Used in fitting. | TORPEDOES. | | All other materials. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Number. | Value. | |
| Total | $511,141 | $17,336 | $22,405 | $5,810 | $131,144 | $16,094 | 41 | $2,330 | $316,022 |
| Allegany | 422,499 | 15,140 | 15,090 | 3,415 | 65,870 | 9,094 | 4 | 368 | 313,522 |
| Erie | 56,325 | | | 175 | 46,000 | 6,500 | 6 | 1,150 | 2,500 |
| Fulton | | | | | | | | | |
| Lewis | 500 | 100 | 400 | | | | | | |
| Niagara | 4,380 | 850 | 3,000 | 50 | 300 | | 3 | 180 | |
| Ontario | 4,328 | 546 | 1,415 | 1,870 | | | 26 | 497 | |
| Oswego | 7,575 | 200 | 2,500 | 300 | 4,000 | 500 | 1 | 75 | |
| Steuben | 15,534 | 500 | | | 14,974 | | 1 | 60 | |

### STATISTICS OF THE PRODUCTION OF NATURAL GAS IN NEW YORK IN 1889.

Below is a condensed statement of the figures regarding the development, production, and consumption of natural gas in New York in 1889:

| | |
|---|---|
| Total amount received for natural gas produced in 1889 | $204, 325 |
| Coal displaced (tons of 2,000 pounds) | 130, 159 |
| Value of same | $530, 026 |

### USES.

| | |
|---|---|
| Total number of fires for cooking and heating | 4, 362 |
| Total number of industrial establishments supplied | 11 |

### WELLS.

| | |
|---|---|
| Number of wells drilling December 31, 1888 | 5 |
| Number of wells drilling December 31, 1889 | 12 |
| Number of wells completed in 1889 | 65 |
| Producing wells completed in 1889 | 55 |
| Dry holes completed in 1889 | 10 |
| Number of wells producing December 31, 1888 | 69 |
| Number of wells producing December 31, 1889 | 119 |
| Number of wells abandoned in 1889 | 3 |
| Total cost of drilling wells, including drive pipe, casing, etc | $74, 752 |
| Labor | $23, 604 |
| Materials | $14, 256 |

### CAPITAL.

| | |
|---|---|
| Number of acres of natural gas land: | |
| Owned | 533 |
| Leased | 49, 337 |
| Total | 49, 870 |
| Total value of land | $298, 120 |
| Total value of rigs, wells, etc | 169, 753 |
| Total value of pipe lines | 580, 519 |
| Total value of other property and improvements | 114, 037 |
| Total capital invested in lands, wells, etc., and used in the business | 1, 162, 429 |

### LABOR AND WAGES.

| | |
|---|---|
| Number of foremen or overseers | 11 |
| Number of mechanics | 37 |
| Number of laborers | 296 |
| Office force, males | 12 |
| Office force, females | 1 |
| Total number of employés | 357 |
| Wages paid foremen or overseers | $4, 152 |
| Wages paid mechanics | 4, 443 |
| Wages paid laborers | 17, 687 |
| Wages paid office force, males | 7, 868 |
| Wages paid office force, females | 85 |
| Total wages paid employés | 34, 235 |

### EXPENDITURES FOR MATERIALS, ETC.

| | |
|---|---|
| Total amount expended in building rigs | $17, 336 |
| Total amount expended in drilling wells | 22, 405 |
| Total amount expended in operating, shutting in, and caring for wells | 5, 810 |
| Total amount expended in pipe, couplings, etc., in building and repairing pipe lines | 131, 144 |
| Total amount expended in fitting | 16, 094 |
| Total amount expended for torpedoes | 2, 330 |
| Total amount expended for all other materials | 316, 022 |
| Total expenditures for materials | 511, 141 |

## MISSOURI.

There have been quite extensive explorations in this state for natural gas, but none of the wells sunk have yielded considerable quantities of the fuel, and the probabilities now are that it will not be found in commercial quantities.

Quite a number of gas springs are known to exist in various parts of the state, especially in the vicinity of Saint Louis, in the eastern part of the state, and Kansas City, in the southwestern section. In Saint Louis, near these springs, gas has been obtained in limited quantities in a number of wells, most of it coming from either the glacial or alluvial drift, but in no case has gas been obtained from rock reservoirs such as those from which the commercial gas in Pennsylvania, Ohio, and Indiana is obtained.

The natural gas in the neighborhood of Saint Louis, to which the most attention has been directed, was that of the Cotton Compress Company. This gas was first struck in 1875, at the bottom of a driven well some 27 feet deep. The supply at first was comparatively abundant for a shallow well, but it soon diminished, until it was only sufficient to illuminate the engine-room. In many wells drilled in Saint Louis to obtain water for the breweries puffs of gas have been found at depths varying from 200 to 1,500 feet.

The existence of gas springs in Kansas City has also been known for many years, and gas is frequently found in connection with the digging or driving of wells in this neighborhood. Quite a number of wells have been drilled in this neighborhood with the hope of obtaining a supply of gas. In a well drilled in the Excelsior brick yard a flow of gas was obtained at 180 feet; in another well, on Seventeenth street, at of 344 feet; in the Kellogg well, near the natatorium, at the depth of 810 feet, and in other wells at depths from 250 to 800 feet, gas having been found at the latter depth in the Tustin well, which is the deepest drilled in Kansas City, it having been sunk to the depth of 1,700 feet.

The only gas that was obtained in Missouri in commercial quantities in 1889 was from Kansas City, Jackson county. The depth of wells is about 480 feet. The sand from which the gas is produced is a reddish sandstone from 10 to 40 feet thick, containing occasionally a thick, black oil. The rock seems to be somewhat similar to that in which oil and gas is found at Paola, Kansas.

Natural gas was supplied to the power house of a cable company at a rental of $1,000 per 100 horse power per annum. Furnaces were supplied for $75 per year, and an 8-room house at $100 per annum.

### STATISTICS OF THE PRODUCTION OF NATURAL GAS IN MISSOURI IN 1889.

The statistics of the production of natural gas in Missouri in 1889, so far as the same could be procured, are as follows:

| | |
|---|---|
| Value of natural gas supplied and used | $27,825 |
| Coal displaced (tons) | 11,859 |
| Value of same | $35,687 |
| Number of fires for cooking and heating | 339 |
| Number of industrial establishments | 2 |
| Number of producing wells completed | 14 |
| Number of dry holes completed | 5 |
| Total number of wells completed during 1889 | 19 |
| Number of producing wells December 31, 1888 | 5 |
| Number of producing wells December 31, 1889 | 13 |
| Number of wells abandoned in 1889 | 8 |
| Total cost of wells completed in 1889 | $30,000 |
| Value of land | $176,800 |
| Value of rigs, wells, etc | 90,800 |
| Value of pipe lines | 44,200 |
| Value of other property | 1,500 |
| Total capital invested in the natural gas industry in 1889 | $313,300 |
| Number of persons employed (excluding contract work) | 2 |
| Total wages paid employés | $85 |
| Total amount expended in building rigs | $500 |
| Total amount expended in pipe, couplings, etc., in building or repairing pipe lines | 12,200 |
| Total amount expended for all other materials | 1,500 |
| Total expenditures for materials | 14,200 |

## KANSAS.

The only district in Kansas in which gas has as yet been found in sufficient quantities to justify its use is in the counties along the eastern border of the state, in Miami, Linn, Bourbon, and possibly others. Gas has also been found in Washington and Marshall counties, on the Nebraska border, and it is possible that it may be found in the shales and sandstones of the western part of the state. It is in the eastern tier of counties, say from Atchison to Cherokee, and especially in the 3 counties above named, that we are to look for commercial supplies of gas.

The surface outcrop on the eastern border of Kansas has two lines of demarcation, forming three distinct geological divisions. The first line occurs near the extreme southeastern corner of the state, where the outcrop of the subcarboniferous strata is bounded by a line drawn from northeast to southwest parallel with the Ozark range of mountains. To the north and west of this line the lower coal measures form the surface rocks and extend north until near the east center of Miami county, where another line of demarcation occurs between the lower and upper series of coal measures, which trends southwest parallel to the former; thence the upper coal measures extend to the north line of the state and west to the Big Blue river. The dip of the rocks in all this region trends about due northwest, or in the direction of a line drawn at a right angle with the Ozark uplift, and amounts to about 6 feet per mile when following the true direction of the dip.

Though gas had been found in prospecting for oil and had been noticed escaping from springs as early as 1864, and again in 1874, it was not until 1882 that what could be termed a gas well was struck at Paola, in Miami county. In 1865 the Saint Louis or Ernstein Oil Company bored two wells for oil some 10 miles east of Paola. The tools were lost at 700 feet, the wells showing some oil. In 1882 a well was bored on the Westfall place, near Paola, which gave gas in considerable quantity. Quite a number of wells have since been bored near the town.

The Paola district has been so thoroughly discussed in connection with the report on petroleum in Kansas that it need not be reported here. It is sufficient to say that most of the gas used in Paola is produced from wells near the town, the pressure of gas in the original field, some 7 miles from Paola, not being sufficient to force the gas through the pipe line to the point of consumption. It may be said that the wells in this district are shallow wells, the gas sand being reached at from 300 to 400 feet.

Possibly the most important developments in connection with the production of natural gas in Kansas have been in the vicinity of Fort Scott, Bourbon county. Over 30 wells have been drilled in this town or its vicinity, gas having been found at various depths. In well No. 1, on the Stewart farm, in Fort Scott, which was drilled to a depth of 281 feet, gas was first struck at a depth of 25 feet. At a depth of 192 feet 10 inches another gas rock was struck, in which gas was found; and the third horizon was in a coal bed at a depth of 277 feet 3 inches. The higher and lower gas veins amounted to nothing, the middle one being that from which gas is obtained. The gas sand is located in the lower coal measures.

The gas when first struck shows a pressure of about 75 pounds. Water soon makes its appearance, and the wells gradually cease to be of value. The gas belt extends through a strip of land about half a mile long and about 1,500 to 2,500 feet wide.

The gas is gradually giving out in this section. That furnished by the Fort Scott Gas Company, which had 1 well in 1889, is a mixture of coal gas and natural gas, and is sold at 50 cents per 1,000 cubic feet. In 1887 and 1888 12 wells were used to supply this town, but all have since been abandoned.

Some gas has been found in Kansas City. Quite a number of wells were put down in this town, some producing gas and some oil, and are about 400 feet deep.

In Labette county a well was drilled in 1881 which has been yielding a supply of gas sufficient for 1 house ever since. This well is 763 feet deep. The rock penetrated was limestone, with thin layers of sandstone. The first vein of gas is found at a depth of 203 feet, the second at 449 feet. The gas pressure is as strong now as when first struck. A few domestic fires are supplied.

Gas was found in a gray shale at a depth of 1,230 feet at Lyons, Rice county. The flow, however, was not very strong, and it has not been utilized.

There is also 1 well at Iola, in Allen county, which supplied some 25 domestic fires in 1889.

### STATISTICS OF THE PRODUCTION OF NATURAL GAS IN KANSAS IN 1889.

The statistics of the production of natural gas in Kansas for 1889 are as follows:

| | |
|---|---|
| Value of natural gas supplied and used | $13,660 |
| Coal displaced (tons) | 4,538 |
| Value of same | $15,873 |

USES.

| | |
|---|---|
| Number of fires for cooking and heating | 798 |
| Number of industrial establishments supplied | 2 |

WELLS.

| | |
|---|---|
| Number of producing wells completed | 14 |
| Number of dry holes completed | 2 |
| Total number of wells completed in 1889 | 16 |
| Number of wells producing December 31, 1888 | 5 |
| Number of wells producing December 31, 1889 | 25 |
| Number of wells abandoned in 1889 | 2 |
| Total cost of drilling wells, including drive pipe, casing, etc., in 1889 | $9,800 |
| Labor | $6,450 |
| Materials | $3,350 |

CAPITAL.

| | |
|---|---|
| Number of acres owned | 2 |
| Number of acres leased | 2,000 |
| Total number of acres of natural gas land | 2,002 |
| Value of natural gas land | $10,200 |
| Value of rigs, wells, etc | 22,500 |
| Value of pipe lines | 27,200 |
| Value of other property | 100,100 |
| Total capital invested in natural gas industry in 1889 | 160,000 |

### LABOR AND WAGES.

| | |
|---|---|
| Total number of employés | 3 |
| Wages paid employés | $2,100 |
| Number of mechanics | 1 |
| Wages paid mechanics | $900 |
| Number of laborers | 1 |
| Wages paid laborers | $200 |
| Number of office force | 1 |
| Wages paid office force | $1,000 |

### EXPENDITURES FOR MATERIALS, ETC.

| | |
|---|---|
| Amount expended in building rigs | $4,500 |
| Amount expended in drilling wells | 6,500 |
| Amount expended in operating and caring for wells | 1,800 |
| Amount expended in pipe, couplings, etc., in building or repairing pipe lines | 1,555 |
| Amount expended for torpedoes | 350 |
| Total expenditures for materials in 1889 | 14,705 |

## CALIFORNIA.

Though natural gas has been found in many parts of the state of California, it is only in the neighborhood of Stockton, in San Joaquin county, and in the oil regions of southern California that it is produced in commercial quantities. In southern California it occurs in connection with the petroleum, and all the capital, labor, etc., is reported as expended in relation with the production of oil. It is estimated that in this section the amount of gas used is equal to some 20 tons of coal for every day in the year, or a total of 7,300 tons. This coal would be worth some $10 a ton, making the value of natural gas produced in southern California in 1889 $73,000.

Natural gas has been known to exist in Sonoma county as early as 1859, and at one or more wells the gas has been collected and used for domestic purposes.

In Contra Costa county natural gas has been observed to bubble up in several mineral springs, and it is also said that it has been found in considerable quantity at Nicasio, Marin county. The gas found near Kelseyville, Lake county, has been used to make steam, and gas has also been found in certain localities in Solano, Sacramento, Tehama, and Mendocino counties, but not, so far as has been learned, in any commercial quantities. In San Joaquin, in the vicinity of the city of Stockton, in Humboldt, and in Los Angeles counties occurs the gas which has been used commercially. The gas found in Los Angeles and Humboldt counties has chiefly been in the sinking of oil wells. The wells on Oil creek, in Humboldt county, sunk in 1866, have since constantly given off gas, and wells sunk in other parts of this county about the same date and since have given continuous flows of gas in some quantity, but from none of the wells in Humboldt county has the flow been sufficient to supply more than two or three burners or to furnish a dwelling house with fuel and light, and that but for a short time.

By far the most important gas-producing district of California, however, is in the neighborhood of Stockton, in San Joaquin county. In the vicinity of this city a large number of artesian wells have been bored. The first of these, the celebrated Court House well, was bored during the years 1854 to 1858. The water coming from the bottom of the well (1,000 feet) brought up with it considerable gas. Quite a number of wells have been bored in this neighborhood, nearly all of which produce gas to a greater or less extent. A well in Castoria township bored in 1883 to a depth of 1,140 feet discharges considerable gas, which is collected in a tank and used for lighting, heating, and cooking in the house of the proprietor. The supply of gas is very much more than sufficient for the purposes named. At the old water works enough gas is collected to cushion the pumps, and at the new water works all 3 wells carry gas. The gas from well No. 1 is passed over gasoline to enrich it in carbon, and is used for lighting the engine room. Altogether 11 ordinary burners are in use, the gas being used directly as it comes from the well. The gas from wells No. 2 and No. 3 is not used. The McDougald well produces a large amount of gas. By actual measurement it registered between 7,000 and 8,000 cubic feet per 24 hours. About 14 miles west of Stockton a well was sunk to a depth of 1,435 feet in 1883 and quite a copious flow of gas was struck.

In December, 1883, the Standard Gas Light and Fuel Company was incorporated at Merced, with the object of developing natural gas in the San Joaquin valley, and in the summer of the next year the California Well Company was organized at Stockton for a similar purpose. The Crown Mills well, an old artesian well, was bored out and sunk to a depth of 1,220 feet, when a large flow of gas was discovered, showing by careful measurements 18,000 cubic feet in 24 hours. A well bored by the California Well Company near Stockton gave a total of 81,000 to 82,000 cubic feet in 24 hours.

In Los Angeles county a considerably greater quantity of gas has been found than in Humboldt. At the Puente wells the gas issues from the wells under a very slight pressure. The quantity is small, and it is drawn directly from the wells to the furnace. As an experiment the gas escaping from No. 5 well was cased in tight, when the pressure increased to about 100 pounds per square inch. It is a remarkable fact in connection with the gas in these wells that it continues to escape from the petroleum for some time after the latter is tanked, and it also appears that the gas thus evolved is capable under some circumstances of redepositing a quantity of liquid petroleum. In Pico cañon, in this same county, there are 2 wells, known as Pico No. 12 and Pico No. 13, the first of which pumps about 18 barrels and the second some 40 barrels a day. These produce a larger quantity of gas than any other wells in this oil section.

The following is an analysis of the gas from a well of the Stockton Natural Gas Company:

ANALYSIS OF NATURAL GAS FROM THE WELL OF THE STOCKTON NATURAL GAS COMPANY.

| | PER CENT. |
|---|---|
| Marsh gas | 83.00 |
| Hydrogen | 0.06 |
| Oxygen | 0.06 |
| Carbonic dioxide | 0.05 |
| Carbonic oxide | Trace. |
| Total | 83.17 |

At the close of 1889 there were 6 producing wells in California. The Asylum well, for which the legislature appropriated $40,000, was boring. The Stockton Gas Light and Heat Company was boring a well adjacent to the Haas well. Stockton county was also drilling a well. The Stockton Gas Company, which owned the Haas well, was putting down a second, and an additional well was being drilled on San Joaquin street, and others were to be drilled.

The wells actually in operation in San Joaquin county in 1889 were the Northern Natural Gas Company's well, which was supplying 10 domestic fires; the Crown Mills well, which was producing from 30,000 to 40,000 cubic feet of natural gas a day, and which was used in lighting the mills and for fuel in the flour mills of the company owning the well; the well of the Citizens' Natural Gas Company, which was drilled in December, 1889; the Haas company's well, which is reported as producing 29,200,000 cubic feet in 1889, supplying only 5 domestic fires; the Paper Mill well of the California Paper Company, producing, as reported, 4,380,000 cubic feet of gas, of which about one-half was consumed in useful work, and the Saint Agnes Academy well, which supplied 8 domestic fires.

STATISTICS OF THE PRODUCTION OF NATURAL GAS IN CALIFORNIA IN 1889.

The statistics of the production of natural gas in California in 1889 are as follows:

| | |
|---|---|
| Value of natural gas supplied and used | $12,680 |
| Coal displaced (tons) | 3,517 |
| Value of same | $12,680 |

USES.

| | |
|---|---|
| Total number of domestic fires | 23 |
| Number of industrial establishments supplied | 5 |

WELLS.

| | |
|---|---|
| Total number of producing wells completed in 1889 | 1 |
| Total number of wells producing December 31, 1888 | 5 |
| Total number of wells producing December 31, 1889 | 6 |
| Total cost of drilling wells, including drive pipe, casing, etc., in 1889 | $5,135 |

CAPITAL.

| | |
|---|---|
| Number of acres of natural gas land owned | 6 |
| Value of natural gas land | $1,900 |
| Value of rigs, well, etc | $49,635 |
| Value of pipe lines | $215 |
| Total capital invested in natural gas industry in 1889 | $51,750 |

The total expenditure in 1889 was $90 for building and repairing pipe lines.

## ILLINOIS.

Gas has been found in Illinois in the following counties: Champaign, Lasalle, Bureau, Livingston, McLean, Dewitt, Macon, Coles, Clark, Montgomery, and Madison, having been first discovered at Champaign in 1853. No field of importance has been developed in this state. The most important wells are at Urbana, Champaign county, Mendota, Lasalle county, and Litchfield, Montgomery county. The Illinois wells, as compared with the great wells in Pennsylvania, are shallow, occurring for the most part in drift, and, though some have yielded gas for years, they are gradually giving out.

The most important gas territory until recently was at Litchfield, in Montgomery county. In this place gas and oil were found at a depth of 650 feet, below the lower coal measures, bordering on the devonian. Gas was first discovered in this place in 1882 and was piped into Litchfield in the fall of 1885, some 4 miles of pipe being laid.

In Randolph county the Sparta Natural Gas Company, which had 1 well prior to 1889, drilled 2 wells in that year, one being dry and the other productive. The depth of the wells is from 848 to 864 feet. A small amount of oil was found in each well before reaching the gas sand. It is quite heavy and black, resembling the West Virginia lubricating oils. The gas from these wells supplied 400 domestic fires and 3 industrial establishments.

At another point in Randolph county gas was struck prior to 1889, and was still producing in the census year. Other drilling was done in this county without success.

In Lasalle county, near Streator, gas has been found in quite a number of wells at a depth of about 100 feet, but it has not been utilized.

Near Mendota, in the same county, 20 wells were sunk in 1888 by the Mendota Natural Gas Company. These wells were drilled to a depth of 160 to 260 feet. Gas was found in all of them, but 17 of the wells gave out at intervals of from 1 to 2 months after gas was struck and the leases reverted to the owners. 3 small wells continued to produce, but only sufficient to supply the residences of the farmers on whose land the wells were drilled. The gas was found in pockets or layers of sand or gravel in the drift or bowlder clay.

In Whiteside county, at Rock Falls, a well was drilled to a depth of 1,014 feet without securing gas.

At Vandalia, in Fayette county, a well was sunk to a depth of 1,150 feet, when it was abandoned, there being no indications of gas-bearing rock.

### STATISTICS OF THE PRODUCTION OF NATURAL GAS IN ILLINOIS IN 1889.

The statistics of the production of natural gas in Illinois in 1889 are as follows:

| | |
|---|---|
| Total value of natural gas supplied and used | $8,658 |
| Coal displaced (tons) | 7,245 |
| Value of same | $10,615 |

#### USES.

| | |
|---|---|
| Number of fires supplied for cooking and heating | 940 |
| Number of industrial establishments | 20 |

#### WELLS.

| | |
|---|---|
| Number of producing wells completed | 2 |
| Number of dry holes completed | 2 |
| Total number of wells completed in 1889 | 4 |
| Number of wells producing December 31, 1888 | 9 |
| Number of wells producing December 31, 1889 | 10 |
| Number of wells abandoned in 1889 | 1 |

#### CAPITAL.

| | |
|---|---|
| Number of acres owned | 44 |
| Number of acres leased | 19,000 |
| Total number of acres of natural gas land | 19,044 |
| Total value of land | $3,200 |
| Value of rigs, wells, etc | 23,620 |
| Value of pipe lines | 18,400 |
| Total capital invested in wells, etc., and employed in the business | 45,220 |

#### LABOR AND WAGES.

| | |
|---|---|
| Number of foremen or overseers | 1 |
| Wages paid foremen or overseers | $750 |
| Number of laborers | 3 |
| Wages paid laborers | $172 |
| Number of office force (males) | 1 |
| Wages paid office force | $300 |
| Total number of employés | 5 |
| Total wages paid employés | $1,222 |

#### EXPENDITURES FOR MATERIALS.

| | |
|---|---|
| Total amount expended for materials in operating, shutting in, and caring for wells | $1,600 |
| Total amount expended for materials used in building and repairing pipe lines | 16,000 |
| Total amount expended for materials in 1889 | 17,600 |

## KENTUCKY.

The chief source of supply of natural gas in Kentucky is from Meade county, in what is known as the Brandenburg district. Some gas was also found in 1889 in Henderson, Breckinridge, and Daviess counties. The first well drilled in Kentucky which produced gas in any considerable quantity was the Moreman well, drilled in 1863 on the Moreman farm, near Brandenburg, Meade county, not far from the Ohio river. Quite a number of other wells drilled for oil about the same time or later produced considerable quantities of gas and brine. In 1872 the

Moreman Salt Works was established, and the gas from the well utilized to make salt from the associated brine. But little use, however, was made of this gas until discoveries in 1885 and 1886 in southern Ohio and Indiana caused great interest to be developed in searching for natural gas in Kentucky. Most of the wells sunk outside of Meade and the counties named above proved unprofitable, but they contributed facts of value regarding the gas and oil horizons in Kentucky.

As the Trenton limestone was the horizon in which oil and gas were found in such quantities in Ohio and Indiana, the discussion regarding the oil and gas strata of Kentucky had reference to this horizon.

The elevation or depression of the base of the Trenton above or below sea level is found in the following table, taken from an admirable article by Professor Moritz Fischer, of the Kentucky geological survey, published in the Natural Gas Supplement of the American Manufacturer. It is from this article by Mr. Fischer and from a paper by Professor Edward Orton that information regarding the gas-bearing strata of Kentucky is obtained.

DISTANCE OF THE BASE OF THE TRENTON LIMESTONE ABOVE OR BELOW SEA LEVEL IN KENTUCKY.

| LOCALITIES. | Feet. | Remarks. |
|---|---|---|
| Cincinnati | 308+ | Near arch of the Cincinnati anticlinal. |
| Lexington | 715+ | |
| High Bridge | 765+ | |
| Harrodsburg | 692+ | |
| Danville | 720+ | |
| Louisville | 584− | Western slope of the Cincinnati anticlinal. |
| Lagrange | 24− | |
| Bardstown | 163− | |
| Lebanon | 36+ | |
| Frankfort | 495+ | West of arch of the Cincinnati anticlinal. |
| Maysville | 82− | East slope of the Cincinnati anticlinal. |
| Richmond | 226+ | |

The oil and gas bearing Trenton limestone of northern Ohio and Indiana is covered by 350 feet of Utica shale, a formation entirely wanting in Kentucky.

A little heavy, dark oil, with weak brine, has been found at a depth of 70 feet near Lexington, Kentucky, in Trenton rock. Near North Middletown, Bourbon county, Kentucky, a well in Lower Hudson 98 feet deep yields 100 gallons of good lubricating oil per week. The oil is black, and has a gravity of 23½° B. The Lower Hudson west and northwest of Cincinnati gives promise of a fair supply of low-pressure gas. A weak flow is obtained in Lewisburg, near Covington, and lately productive wells have been found near Cincinnati, in Cheviot, at Lawrenceburg, and Aurora, Indiana. This horizon is likely to be found in the river counties west of Covington, and may prove quite remunerative. Weak flows of gas have been obtained from wells sunk in the neighborhood of Louisville on both sides of the Ohio river. Data obtainable are not sufficient to locate the horizon or productive formation. It would seem to lie in either upper or middle Hudson, at least for the Third street well, Louisville, and the wells located at Old Deposit, near Louisville, one of the latter giving a flame 20 feet high. The flow increased since gas was first struck. The Clinton and Niagara district has been penetrated by a number of wells, but gives no encouragement to the prospector. These wells being near the outcrop of the formations, their evidence is not conclusive.

The black shale is the most promising oil and gas horizon in the state, having an average of 10 per cent of bitumen. This shows an enormous amount of hydrocarbons stored in it. The following data were furnished by Major William T. Davis, of Louisville, Kentucky:

SECTION OF MOREMAN WELL, BRANDENBURG, MEADE COUNTY, KENTUCKY.

| LOCALITIES. | Feet. | Remarks. |
|---|---|---|
| Saint Louis | 50 | Gas and strong brine; well sunk 1864; flows with undiminished force. |
| Keokuk | 450 | |
| Lick shales | 5 | |

SECTION OF DOE RUN WELL, ROCK GAS COMPANY, NEAR BRANDENBURG, MEADE COUNTY, KENTUCKY.

| LOCALITIES. | Feet. | Remarks. |
|---|---|---|
| Keokuk | 475 | Gas and strong brine; daily flow 1,000,000 cubic feet. |
| Lick shales | 15 | |

SECTION OF MAJOR DAVIS WELL, TOBACCO LANDING, HARRISON COUNTY, INDIANA, 5 MILES EAST OF BRANDENBURG, KENTUCKY.

| LOCALITIES. | Feet. | Remarks. |
|---|---|---|
| Keokuk | 375 | Gas and strong brine, measured by Mr. Ashburner, showing a daily flow of 805,000 cubic feet; flow increased slightly since. |
| Lick shales | 25 | |

These are constant wells, and the field deserves careful attention as the most promising source of a supply for Louisville. Adjacent to the Cumberland anticlinal much oil has been obtained from the black shale. Wells 100 to 250 feet deep have sometimes produced 300 barrels a day.

The gas from the Meade county field is a shale gas, its source being the black or Ohio shale, which under various names has long been known as a gas producer. It is from this horizon that the gas from Fredonia, in western New York, is obtained. Wells have been drilled by the hundreds along the lake shore in western New York and Ohio in search of gas for household use. There is not a single township along the line of the outcrop of this formation, from Silver Creek, in New York, to Huron river, in Ohio, in which wells have not been drilled for gas. Erie, in Pennsylvania, and Conneaut, Ashtabula, Painesville, and Cleveland, in Ohio, may be all named as places using gas from this horizon.

While the Meade county gas is, without doubt, derived from the black shale, agreeing in composition with the gas from these measures in the Ohio field, Professor Orton points out that all the important conclusions as to the characteristics of shale, as drawn from the experience with the gas from New York and Ohio, are promptly set aside by the experience with the Meade county gas. Unlike the Ohio shale gas, the Meade county gas is reservoir or high-pressure gas. It is associated with and driven by a salt-water column. Its wells have attained a maximum production of 2,000,000 cubic feet per day. They are greatly improved by the use of torpedoes. The rock pressure is low, it is true, but this evidently results from the shallow depth at which the gas rock is found, for the depth is always a function of the rock pressure in reservoir wells. In the heart of the new field the rock pressure ranges from 100 to 125 pounds per square inch, the depth of the wells ranging from 300 to 500 feet below the surface. Again, the gas wells of this district produce salt water freely in connection with the gas, without, in all cases at least, being overrun by it.

Commenting on these facts, Professor Orton says:

> All this is confusing to a high degree. It seems at first sight as if such an experience destroyed all possibilities of scientific or practical provision in the search which our cities and towns are so eagerly pressing; but a closer examination shows us that only a single change has occurred in the character of the shale. Through the accidents of its history it has become a porous rock, and consequently a reservoir for gas, oil, and salt water. All the other changes above noted follow at once upon the transformation of the shale from an approximately impervious rock to a porous rock.

Though, as stated above, the first gas well in this district was the Moreman well of 1863, the real development of this section as a gas-producing district began with the boring of well No. 1, known as the Major Davis well of the Union Gas Company, drilled in 1887 near Tobacco Landing, on the Indiana side. A daily flow of 805,000 cubic feet of dry gas was obtained from this well at a depth of about 400 feet. At least 3 other wells, 1 unproductive, have been drilled by this company. The total production of these wells is 2,500,000 cubic feet daily.

The Kentucky Rock Gas Company has drilled a number of wells on the Fountain, McGehee, Bickerstaff, and other farms in this immediate district, and it is this group of wells that mainly gives character to the field.

The first well to be drilled by this company was the one known as the Bickerstaff well No. 1. It found the shale at a depth of 386 feet, and gas was found in good volume at 392 feet. The well was completed in January, 1888, and was allowed to burn without check until March, when it was shut in. On being opened a few weeks thereafter it was found to contain salt water. The water gained rapidly upon the gas, greatly reducing its flow. This is a type of several wells that have been drilled within the limits of the company; in some, indeed, the salt water making the conspicuous feature of the production.

Another and better type is represented in the Bickerstaff well No. 2. In this the shale was found at 342 feet and gas in large volume at 368 feet. The well was torpedoed with 45 pounds of dynamite of 75 per cent strength, and the flow of gas was greatly increased thereby. The gas proves to be entirely dry, and its production exceeds 2,000,000 cubic feet per day.

This company did not complete its arrangement to supply customers until December, 1889, at which time it had 10 wells in operation, drilling none during 1889. They estimate the total production of their wells for the year 1889 as 1,095,000 cubic feet, of which only about 10 per cent was consumed, the remainder going to waste.

The only other county in Kentucky in which natural gas was used was in Breckinridge county. About the middle of 1889 developments were commenced in this county, several wells being drilled, 4 of which were dry holes.

In Henderson county 4 wells were drilled, 2 of which were dry, the others showing a closed pressure of from 50 to 60 pounds, which soon dropped to 40 or 50 pounds. None of the gas was utilized, there being no market and the quantity thought insufficient to warrant piping.

A well was drilled in Daviess county in December, 1889. Gas was found at a depth of 850 feet. The well is filled with salt water, the gas rising through it. No use was made of this gas.

In the following tables will be found the statistics of the production of natural gas in Kentucky by counties:

PRODUCTION OF NATURAL GAS IN KENTUCKY IN 1889, BY COUNTIES.

| COUNTIES. | Value of natural gas supplied and used. | COAL DISPLACED. | |
|---|---|---|---|
| | | Tons. | Value. |
| Total | $2,580 | 615 | $2,580 |
| Breckinridge | 100 | 20 | 100 |
| Meade | 2,480 | 595 | 2,480 |

The gas produced in Kentucky in 1889 was used as follows: in Breckinridge county 2 industrial establishments were supplied; in Meade county 6 fires for cooking and heating and 2 industrial establishments were supplied.

WELL RECORD, BY COUNTIES.

| COUNTIES. | WELLS COMPLETED IN 1889. | | | NUMBER OF WELLS PRODUCING. | | Wells abandoned. | Total cost of drilling wells, including drive pipe, casing, etc. | DETAIL OF COST. | |
|---|---|---|---|---|---|---|---|---|---|
| | Total. | Producing. | Dry holes. | December 31, 1888. | December 31, 1889. | | | Labor. | Material. |
| Total | 29 | 21 | 8 | 20 | 37 | 13 | $26,750 | $1,500 | $1,000 |
| Breckinridge | 5 | 2 | 3 | | 2 | 3 | | | |
| Daviess | 2 | 2 | | | 2 | 1 | 2,500 | 1,500 | 1,000 |
| Henderson | 4 | 2 | 2 | | 2 | 2 | 4,100 | | |
| Meade | 18 | 15 | 3 | 20 | 31 | 7 | 20,150 | | |

COMPLETED WELLS IN 1889.

| MONTHS. | Total number of wells completed in each month. | Number of dry holes. | Number of wells producing. |
|---|---|---|---|
| Total | 29 | 8 | 21 |
| January | 2 | 2 | |
| February | | | |
| March | 1 | | 1 |
| April | 3 | 2 | 1 |
| May | 2 | | 2 |
| June | 5 | 1 | 4 |
| July | 2 | 1 | 1 |
| August | 2 | | 2 |
| September | 1 | | 1 |
| October | 4 | | 4 |
| November | 4 | 1 | 3 |
| December | 3 | 1 | 2 |

PRODUCING WELLS.

| MONTHS. | Total number producing. | Total number abandoned. |
|---|---|---|
| 1888. | | |
| December 31 | 20 | |
| 1889. | | |
| January 31 | 20 | 2 |
| February 28 | 20 | |
| March 31 | 21 | |
| April 30 | 22 | 2 |
| May 31 | 24 | |
| June 30 | 26 | 3 |
| July 31 | 27 | 1 |
| August 31 | 29 | |
| September 30 | 30 | 2 |
| October 31 | 32 | |
| November 30 | 35 | 1 |
| December 31 | 37 | 2 |

### CAPITAL INVESTED IN THE NATURAL GAS INDUSTRY IN KENTUCKY IN 1889.

| COUNTIES. | Total capital. | NUMBER OF ACRES OF NATURAL GAS LAND. | | | | VALUE OF PLANT. | | |
|---|---|---|---|---|---|---|---|---|
| | | Total acreage. | Owned. | Leased. | Value of land. | Rigs, wells, etc. | Pipe lines. | Other property. |
| Total | $2,146,400 | 23,215 | 3,800 | 19,415 | $275,550 | $128,950 | $800,700 | $941,200 |
| Breckinridge | 19,000 | 3,000 | .......... | 3,000 | 1,000 | 18,000 | .......... | .......... |
| Daviess | 5,800 | 1,000 | .......... | 1,000 | 3,000 | 2,800 | .......... | .......... |
| Henderson | 4,100 | 3,800 | 3,800 | .......... | 2,050 | 2,050 | .......... | .......... |
| Meade | 2,117,500 | 15,415 | .......... | 15,415 | 269,500 | 106,100 | 800,700 | 941,200 |

### LABOR AND WAGES, MEADE COUNTY.

| EMPLOYÉS. | Number. | Wages. |
|---|---|---|
| Total | 21 | $13,016 |
| Foremen or overseers | 3 | 3,360 |
| Mechanics | 14 | 8,056 |
| Laborers | 3 | 520 |
| Office, males | 1 | 1,080 |

### TOTAL EXPENDITURES FOR MATERIALS DURING 1889, BY COUNTIES.

| COUNTIES. | Total. | Building rigs. | Operating, shutting in, and caring for wells. | Pipe, couplings, etc., used in fitting and repairing pipe lines. | TORPEDOES. | | All other materials. |
|---|---|---|---|---|---|---|---|
| | | | | | Number. | Value. | |
| **Total** | $15,644 | $500 | $1,700 | $6,000 | 15 | $1,444 | $6,000 |
| **Breckinridge** | 350 | .......... | .......... | .......... | 2 | 350 | .......... |
| **Henderson** | 100 | .......... | .......... | .......... | 3 | 100 | .......... |
| **Meade** | 15,194 | 500 | 1,700 | 6,000 | 10 | 994 | 6,000 |

### STATISTICS OF THE PRODUCTION OF NATURAL GAS IN KENTUCKY IN 1889.

Below is a condensed statement of the figures regarding the development, production, and consumption of natural gas in Kentucky in 1889:

| | |
|---|---|
| Total amount received for natural gas produced in 1889 | $2,580 |
| Coal displaced (tons) | 615 |
| Value of same | $2,580 |

#### USES.

| | |
|---|---|
| Total number of fires for cooking and heating | 6 |
| Total number of industrial establishments supplied | 4 |

#### WELLS.

| | |
|---|---|
| Number of producing wells completed in 1889 | 21 |
| Number of dry holes completed in 1889 | 8 |
| Number of wells completed during 1889 | 29 |
| Number of wells producing December 31, 1888 | 20 |
| Number of wells producing December 31, 1889 | 37 |
| Number of wells abandoned in 1889 | 13 |
| Total cost of drilling wells completed in 1889 | $26,750 |
| Labor | $1,500 |
| Materials | $1,000 |

#### CAPITAL.

| | |
|---|---|
| Number of acres owned | 3,800 |
| Number of acres leased | 19,415 |
| Total | 23,215 |
| Total value of land | $275,550 |
| Total value of rigs, wells, etc | 128,950 |
| Total value of pipe lines | 800,700 |
| Total value of other property and improvements | 941,200 |
| Total capital invested in lands, wells, etc., and used in the business | 2,146,400 |

### LABOR AND WAGES.

| | |
|---|---|
| Number of foremen or overseers | 3 |
| Number of mechanics | 14 |
| Number of laborers | 3 |
| Number of office force (males) | 1 |
| Total number of employés | 21 |
| Wages paid foremen or overseers | $3,360 |
| Wages paid mechanics | 8,056 |
| Wages paid laborers | 520 |
| Wages paid office force (males) | 1,080 |
| Total wages paid employés | 13,016 |

### EXPENDITURES.

| | |
|---|---|
| Building rigs | $500 |
| Operating, shutting in, and caring for wells | 1,700 |
| Pipe, couplings, etc., in building or repairing pipe lines | 6,000 |
| Torpedoes | 1,444 |
| All other materials | 6,000 |
| Total expenditures for materials | 15,644 |

## WEST VIRGINIA.

While gas has been found in some quantities in this state from the time Washington secured possession of the "burning springs" in Kanawha valley, most of the gas consumed in the state at present is piped from Washington county, Pennsylvania. A great many wells have been bored in various parts of the state, but as a rule they have not furnished gas in commercial quantities. But little natural gas was reported as produced in this state in 1889, and this all in Kanawha county. Gas was produced in other counties, but was not used, all going to waste.

### STATISTICS OF THE PRODUCTION OF NATURAL GAS IN WEST VIRGINIA IN 1889.

The statistics of the production of natural gas in West Virginia in 1889 are as follows:

| | |
|---|---|
| Value of natural gas supplied and used | $2,000 |
| Amount of coal displaced (tons) | 600 |
| Value of same | $2,000 |

### USES.

| | |
|---|---|
| Total number of fires for cooking and heating | 5 |
| Total number of iron rolling mills supplied (*a*) | 6 |
| Total number of other industrial establishments supplied | 1 |

### WELLS.

| | |
|---|---|
| Number of producing wells completed | 5 |
| Number of dry holes completed | 1 |
| Total number of wells completed in 1889 | 6 |
| Total number of wells producing December 31, 1889 | 4 |
| Total number of wells abandoned | 1 |
| Cost of labor | $1,600 |
| Cost of materials | 400 |
| Total cost of completing wells in 1889 | 2,000 |

### CAPITAL.

| | | |
|---|---|---|
| Total number of acres of leased land | 218 | |
| Value of natural gas land | | $11,280 |
| Value of rigs, wells, etc. | | 103,395 |
| Value of pipe lines | | 25 |
| Total capital invested in the natural gas industry | | 114,700 |

### LABOR AND WAGES.

| | |
|---|---|
| Number of mechanics | 6 |
| Wages paid mechanics | $1,800 |

[a] These mills procured their gas from Pennsylvania.

## TEXAS.

At Dullnig's ranch, 6.5 miles south of San Antonio, in Bexar county, Texas, a number of wells were in process of drilling for natural gas at the close of 1889. In drilling a well prior to 1889 a small amount of gas was found, but this was not utilized for any other purpose than in drilling other wells and for lighting and cooking on the ranch. The quantity of gas was not sufficient for these purposes and drilling, so one-half wood was used. The open pressure of the gas was 25 to 30 pounds; the confined pressure 70 to 100 pounds, as tested by a steam gauge. 5 wells were being drilled at the close of the year 1889, but had not been completed.

It is estimated that the value of the gas used in 1889 was $1,728, equivalent to a coal displacement of 288 tons.

### NATURAL GAS STATISTICS IN TEXAS IN 1889.

| | |
|---|---|
| Number of foremen or overseers | 1 |
| Wages paid foreman (225 days, at $4 a day) | $900 |
| Number of mechanics | 1 |
| Wages paid mechanic (240 days, at $3 a day) | $720 |
| Number of laborers | 1 |
| Wages paid laborer (240 days, at $1.50 a day) | $360 |
| Total capital invested in lands, wells, pipe lines, etc., and used in business | $80,000 |
| Number of acres of natural gas land owned | 725 |
| Present value of land | $72,500 |
| Value of rigs, wells, engines, boilers, etc | $1,500 |
| Value of other property and improvements | $6,000 |

### PRODUCING WELLS.

The number of producing wells in Texas for December, 1888, and the year 1889, by months, was as follows: December, 1888, 1; in 1889, 1 each for January, February, March, April, May, June, July, August, September, October, November, and December.

## ARKANSAS.

There has been quite an amount of drilling in Arkansas for natural gas, but so far it has not been found in commercial quantities. The Arkansas Natural Gas and Oil Company of Fort Smith put down several wells, but abandoned operations in 1888. The only well producing in this state in 1889, so far as returns have been received, was 1 sunk by the Fort Smith Natural Gas and Power Company in Upper township, Sebastian county. 2 wells were completed by this company in 1889, 1 in February, which was a dry hole, and 1 in September, which produced. 1 well was drilled in 1888, which is reported to have produced 500,000 cubic feet per day, having a closed pressure of 250 pounds per square inch. This well has been open and flowing since November, 1888, with no perceptible diminution of pressure. Both of these productive wells were drilled to a depth of 2,780 feet. The only use made of the gas was in the residence of the owner of the farm on which the gas was struck, this family using only a small proportion of the production and saving in fuel only some $75 by its use. In putting down the 2 wells that were drilled in 1889 the use of gas in drilling saved the company some $300. This company was compelled to abandon work near the close of 1889 from lack of capital. It is estimated, as stated above, that the total value of the gas consumed was $375, which would represent a coal equivalent of 107 tons.

### NATURAL GAS STATISTICS IN ARKANSAS IN 1889.

| | |
|---|---|
| Total capital invested in lands, wells, pipe lines, etc., and used in business | $24,000 |
| Number of acres of land leased | 2,000 |
| Present value of land leased | $20,000 |
| Value of rigs, wells, engines, boilers, etc | $3,500 |
| Value of other property and improvements | $500 |
| Total cost of drilling wells in 1889, including cost of rigs, drive pipe, casing, and tubing | $8,000 |
| Amount of wages paid for labor | $2,500 |
| Cost of materials | $5,500 |

### NUMBER OF COMPLETED NATURAL GAS WELLS IN ARKANSAS IN 1889.

| MONTHS. | Total number of wells completed in each month. | Number of dry holes. | Number of producing wells. | Initial pressure of new wells. (Pounds.) (*a*) | Estimated daily production of new wells. (Cubic feet.) |
|---|---|---|---|---|---|
| Total | 2 | 1 | 1 | 250 | 25,000 |
| January | | | | | |
| February | 1 | 1 | | | |
| March | | | | | |
| April | | | | | |
| May | | | | | |
| June | | | | | |
| July | | | | | |
| August | | | | | |
| September | 1 | | 1 | 250 | 25,000 |
| October | | | | | |
| November | | | | | |
| December | | | | | |

*a* Pressure closed.

One well was torpedoed during the year 1889, at a cost of $800.

### PRODUCING WELLS.

The total number of producing wells in Arkansas for December, 1888, and the year 1889, by months, was as follows: December, 1888, 1; in 1889, 1 each for January, February, March, April, May, June, July, and August, and 2 each for September, October, November, and December. One well was abandoned in February, 1889.

## UTAH.

Frequent statements are made as to the existence of natural gas in quantities in Utah, but so far the amount discovered has been very small, and this chiefly on the shores of Salt Lake, near Ogden.

In Salt Lake City small amounts of gas are frequently found in putting down driven wells. The gas seems to rise at short intermittent intervals to the amount of not over 2 or 3 cubic feet in 5 minutes; the production then becomes water for a while, and at an interval gas rises again.

At Lake Shore, the old Utah Central bathing resort, natural gas has been used in the manufacture of salt. 4 years ago 4 large jets of natural gas were burned under a vat 5 by 12 feet and 14 inches deep.

Only a small part of the gas is at present collected. The gas water is allowed to flow into a barrel, the gas collecting at the top, the water being driven out at the bottom. This gas is conveyed by a pipe and hose into a house near the place where it is produced, and used for cooking and heating.

At Ogden is a well which has been producing for 4 years, the gas being used for illuminating purposes, and also for cooking and heating stoves in the residence of the owner.

These wells are 148 feet deep, and were sunk for supplying water for irrigation. Two gasometers were constructed, and the gas supplied some 20 lights from burners using 2 to 5 feet per hour, and also sufficient for cooking and heating.

It is also reported that a well in Boxelder county produced considerable gas, but no information could be secured regarding it.

### STATISTICS OF THE PRODUCTION OF NATURAL GAS IN UTAH IN 1889.

The statistics of the production of natural gas in Utah for 1889 are as follows:

| | |
|---|---|
| Value of natural gas supplied and used | $150 |
| Coal displaced (tons) | 18 |
| Value of same | $150 |
| Number of fires for cooking and heating | 6 |
| Number of wells producing December 31, 1888 | 2 |
| Number of wells producing December 31, 1889 | 2 |
| Value of rigs, wells, etc | $2,970 |
| Value of pipe lines | 30 |
| Total capital invested in natural gas industry | 3,000 |

## SOUTH DAKOTA.

Natural gas is very frequently found in various sections of South Dakota in sinking wells for water. So far as records have been received, gas in any considerable quantities was first struck near Ashton, South Dakota, at a depth of 78 feet, and was used for 6 weeks in the Bowman House, in Ashton, for cooking. The well filled with water and drowned out the gas. In this neighborhood quite a number of wells have been sunk, in most of which gas in small quantities has been found, varying in depth from 75 to 200 feet. The gas is found in a black shale and sandstone. In some instances the supply was just enough to show that gas existed in the rock; in other wells the quantity of gas at first appeared to be quite large, having a closed pressure of from 15 to 40 pounds.

The drill usually passes through about 15 feet of soil and clay, and then through 55 feet of hardpan, soapstone, and black shale, the gas sometimes being found in this shale and sometimes in a light-colored sandstone immediately under the shale. A small amount of oil is also found. In many instances no drilling is done, the casing being driven to the gas rock.

Several wells produced a small amount of gas in 1889, and it is reported that somewhere in the neighborhood of $4,000 was spent in sinking test wells for natural gas within a radius of 25 miles of Ashton.

## STATISTICS OF THE PRODUCTION OF NATURAL GAS IN SOUTH DAKOTA IN 1889.

The statistics of the production of natural gas in South Dakota, so far as the same could be procured, are as follows:

| | |
|---|---|
| Value of natural gas supplied and used | $25 |
| Coal displaced (tons) | 5 |
| Value of same | $25 |
| Number of fires for cooking and heating | 1 |
| Number of wells drilling December 31, 1888 | 1 |
| Number of producing wells drilled during 1889 | 2 |
| Number of wells producing December 31, 1889 | 1 |
| Number of wells abandoned in 1889 | 1 |
| Value of rigs, wells, etc | $1,273 |
| Value of pipe lines | 87 |
| Total capital invested | 1,360 |
| Total number of employés | 1 |
| Wages paid employés | $73 |

## NEW MEXICO.

It is reported that while a well was being sunk by the Cosmopolitan Petroleum Company in Navajo Church mining district, in Barnalillo county, New Mexico, for petroleum, gas was struck at some 300 feet from the surface. As petroleum was the object sought for, the well was drilled past the gas to a depth of 500 feet, when it was abandoned for lack of capital. Some $2,000 was paid in wages for this work, the total capital invested in lands, wells, pipe lines, etc., being $3,000.

## TENNESSEE.

No natural gas was produced in Tennessee in 1889, though the conditions here are such as to make some reference to them of interest.

The coal measures of Tennessee are badly denuded. They contain no Catskill, Chemung, or Portage to supply the gas sands, oil sands, shale covers, etc., nor is there any Ohio or Indiana Utica shale to serve as a cap for the rich store of material escaping from the Trenton limestone. Referring to the prospect of securing gas in the central basin of Tennessee, the floor of which is made of outcropping Hudson river and Trenton limestones, Professor Safford, in a contribution to the Natural Gas Supplement, No. 2, of the American Manufacturer, says that they are charged with a measure of gas is proved by the fact that for the last 60 years and more wells bored in the limestones have yielded gas, often in quantities to astonish and bewilder the Tennessee borers. The wells have been usually driven for water, sometimes for salt water. They do not always yield a noticeable volume of gas, though it is common for them to do so. The gas wells are not confined to any special part of the basin. One bored within the limits of the city of Nashville supplied a flow of gas which, when ignited, burned with a volume of flame 8 feet high. It continued to flow for 6 weeks, the volume, however, growing less and less until it ceased to attract attention. This gas was for a time utilized in a house near by for lighting purposes. The well is only about 80 feet deep. It was started in the lower limestones of the Hudson river series and terminated in the Trenton. Another well, 20 or 22 miles southeast from Nashville, and wholly within the Trenton, bored for water in 1858, reached gas at a depth of less than 100 feet, which blew out strongly and burnt furiously, greatly alarming the owners, who fled and could not be induced to return for some time. About October 1, 1887, another well, 12 miles northeast from Murfreesboro, and in the Trenton, was also bored for water, and at about 100 feet yielded a similar exhibition of gas. And still another, on the eastern side of the basin, at a depth of 52 feet supplied a volume of gas which burned at the end of a 5-inch stovepipe with a flame 3 feet high, and so continued for several days without diminution. These are but a few examples of many that might be given. They illustrate the general character of burning wells of the basin. The gas is of low pressure, and is met with both in the Hudson river and Trenton rocks. Professor Safford thinks that the gas of such wells, some of them at least, if properly cared for, could in a small way be made useful for domestic purposes and for a considerable length of time. So far no high-pressure gas has been found. The deep wells sunk for the purpose have been failures. One at Nashville reached a depth of 1,250 feet without any special show of gas.

In the "Rim" the Hudson and the underlying Trenton are found under the characteristic strata of this section, which is the subcarboniferous. As a rule, more or less gas has been met with in drilling oil wells, which are found in front of the Cumberland table-land on the "Rim" area, but the amount is comparatively small. In several counties along the western base of the Cumberland table-land, as in White and Warren counties, moderate quantities of gas have been encountered in wells drilled for salt or petroleum. West of Nashville some gas has been found. Nearer Nashville, at the western edge of the Central basin, a well has been drilled, starting in the Niagara and descending into the Hudson and Trenton, in all a depth of 1,620 feet. At a depth of 250 feet in the Hudson gas was encountered which blazed up 4 or 5 feet when ignited. Below this no more gas was encountered.

2 wells were bored in 1887, 6 and 8 miles, respectively, from Chattanooga, with no important results. A little gas was met with in one of them, which, when fired, blazed up for a few minutes.

Relative to natural gas in Tennessee, Professor Safford reaches the following conclusions: "(1) the gas so far obtained in Tennessee has no practical value, and (2) the gas and oil, such as we have, come from the Hudson river and Trenton limestones."

Relative to operations in Tennessee in 1889, it may be said that near the close of 1888 the Chattanooga Oil and Gas Company drilled a well in Shirleyton to a depth of 1,700 feet. A small flow of gas was found at 900 feet which was sufficient to make a blaze about 10 feet in height through a 10-inch pipe. It seemed to hold its strength for several months after work was abandoned, and the gas continues to flow. At a distance of about 1,400 feet a small quantity of very dark strong oil was found, but the company, being organized solely for the purpose of experimenting, abandoned work at about 1,700 feet and nothing more was ever done. The gas was found in a sandstone, and the oil in a limestone. The well was located in the synclinal valley, described by State Geologist Dr. Safford, of the Vanderbilt university of Nashville, as a trough dug out from the diverging point of the Waldens ridge from the Cumberland mountains. It is in the west side of the valley, which has sandstone formation chiefly, while on the east side it is almost totally limestone. Another well was drilled by this company about 2 miles south of Chattanooga to the same depth, the entire work being in solid limestone. Altogether about $3,000 was expended, which exhausted the company's funds, and work ceased.

The Knoxville Natural Gas Company drilled a well at Oliver Springs, in Anderson county, in 1889. At about 1,800 feet a thin gas sand was found, which produced a small amount of gas that burned for several hours. Drilling was continued to 1,860 feet, when the venture was abandoned.

### STATISTICS OF THE PRODUCTION OF NATURAL GAS IN TENNESSEE IN 1889.

The statistics of the production of natural gas in this state in 1889 are as follows, showing only capital invested and wells drilled and abandoned:

| | |
|---|---|
| Number of completed wells producing | 1 |
| Number of dry holes completed | 1 |
| Total number of wells completed in 1889 | 2 |
| Total number of acres of natural gas land owned | 270 |
| Total value of land | $2,700 |
| Value of rigs, wells, etc | 11,800 |
| Total capital invested in natural gas industry | 14,500 |

## WISCONSIN.

So far as has been ascertained, the only natural gas produced in Wisconsin in the census year was in Oak Creek township, Milwaukee county. 3 wells were drilled during the year; 1 began producing in July, 1 in September, the third well drilled being a dry hole. The initial pressure of the gas was 40 pounds. This was rapidly reduced, however, to 4 pounds closed pressure, with 2½ ounces flowing pressure through a 4-inch pipe.

The estimated daily production of the well drilled in July was 885,000 cubic feet; of the one drilled in September, 200,000 cubic feet. The estimated total production of these wells for the year ended December 31, 1889, was 120,000,000 cubic feet.

At the close of 1889 no use had been made of this gas.

### STATISTICS OF THE PRODUCTION OF NATURAL GAS IN WISCONSIN IN 1889.

The statistics of the production of natural gas in this state are as follows:

| | |
|---|---|
| Number of wells drilled in 1889 | 3 |
| Number of wells producing December 31, 1889 | 2 |
| Number of dry holes | 1 |
| Total production of wells during the year ended December 31, 1889 (cubic feet) | 120,000,000 |
| Total number of employés | 6 |
| Total wages paid employés | $1,600 |
| Number of foremen or overseers | 1 |
| Total wages paid foremen or overseers | $400 |
| Number of laborers | 5 |
| Total wages paid laborers | $1,200 |
| Total number of days each was employed | 160 |
| Total capital invested in lands, wells, etc., and used in the business | $4,100 |
| Number of acres of gas lands leased | 160 |
| Value of natural gas land | $1,600 |
| Value of rigs, wells, engines, boilers, etc | $2,500 |
| Total cost of drilling wells in 1889, including cost of rigs, drive pipe, casing, and tubing | $2,500 |
| Amount of wages paid labor | $1,600 |
| Cost of materials | $900 |

# ASPHALTUM.

# ASPHALTUM.

BY E. W. PARKER.

Gilsonite, elaterite, uintite, wurtzilite, albertite, grahamite, asphaltum, maltha, and brea are names given to various semisolid bitumens, which differ considerably from one another in their chemical composition, in their action with acids or other agents, and upon the application of heat; but as every one of them has been called asphaltum, it is deemed advisable for the purposes of the Eleventh Census to group them under that head. This is partly for convenience, but particularly because asphaltum is the common term applied to the class when used industrially, the varieties being designated by the producing locality, and because these substances, through somewhat different processes of manufacture, are used for the same purposes. Asphaltum will be distinguished in this report from asphalt, in that the latter term is usually applied to the manufactured article used for street paving, while the crude mineral is better known as asphaltum.

## PRODUCTION IN PREVIOUS YEARS.

From 1882 to 1885, inclusive, the product was estimated at 3,000 short tons per year, having an average value of $10,500. In 1886 the production increased slightly, being 3,500 short tons, value $14,000. In 1887 a still further increase was noted; the product was 4,000 short tons, value $16,000. The production each year was limited to California. The figures for 1888, as published in the Mineral Resources of the United States, show a remarkable increase, due to the production in California of 50,000 tons of bituminous rock (a sandstone formation impregnated with asphaltum), which then came into the market as a competitor with other kinds of material for street paving. In addition to this, 450 tons of gilsonite, valued at $22,500, were produced in the territory of Utah. The value of the total product was estimated at $331,500, but in this aggregate the value of bituminous rock was taken at the price free on board cars. The value at the mines was about $165,000.

## PRODUCTION IN THE YEAR 1889.

The product of bituminous rock for the year 1889 was about the same as that for 1888. California produced 47,968 short tons, valued at $126,885 at the mines; Utah, 3,163 short tons, valued at $15,000, and a small amount, 112 tons, valued at $252, was produced in Kentucky. The production of gilsonite in Utah increased slightly, being 492 short tons, valued at $29,400.

The tables following show the product of asphaltum and bituminous rock for the United States for the calendar year 1889, the number of men employed, the average wages per day, and the capital invested in the industry.

ASPHALTUM PRODUCED IN THE UNITED STATES IN 1889.

| STATES. | Product. (Short tons.) | Value. |
|---|---|---|
| Total | 51,735 | $171,537 |
| California (bituminous rock) | 47,968 | 126,885 |
| Kentucky (bituminous rock) | 112 | 252 |
| Utah (bituminous rock) | 3,163 | 15,000 |
| Utah (gilsonite) | 492 | 29,400 |

### EMPLOYÉS AT ASPHALTUM MINES.

| DESIGNATION. | Average number employed. | Average wages per day. | Average number of days worked. |
|---|---|---|---|
| Total | 136 | | |
| Above ground: | | | |
| Foremen | 7 | $3.30 | 156 |
| Mechanics | 2 | 3.25 | 243 |
| Laborers (*a*) | 110 | 2.07 | 244 |
| Office force | 2 | | |
| Below ground: | | | |
| Foremen | 1 | 2.00 | 172 |
| Miners | 11 | 3.27 | 135 |
| Laborers | 3 | 2.00 | 173 |

*a* Includes the number employed at 2 mines in California, where work was performed by contract, operators paying 75 cents per ton for mining.

### WAGES AND OTHER EXPENSES AT ASPHALTUM MINES.

| | | |
|---|---|---|
| Wages paid in 1889: | | |
| Labor | $63,503 | |
| Office force at the mines | 3,000 | |
| | | $66,503 |
| Paid to contractors | | 8,340 |
| Paid for supplies | | 13,884 |
| All other expenses (such as rent, insurance, taxes, interest, commissions, etc.) | | 9,610 |
| Total | | 98,337 |

### CAPITAL INVESTED.

| | |
|---|---|
| In land | $2,429,300 |
| In buildings, machinery, etc | 37,100 |
| In tools, implements, live stock, etc | 139,600 |
| Cash (not included in foregoing items) | 45,500 |
| Total | 2,651,500 |

## VARIETIES AND LOCALITIES.

Elaterite, albertite, and grahamite are very nearly alike in composition and physical properties. The first occurs principally in Derbyshire, England, and was so named by Hausmann, on account of certain elastic tendencies and its resemblance to India rubber. Albertite, a very similar mineral, occurs in Nova Scotia. Grahamite was found in West Virginia, but the deposit was small and has been exhausted.

Gilsonite and uintite (or uintahite) are the names given to the asphaltum of Utah, which is the purest that has yet been found, the crude mineral containing about 90 per cent of bitumen. It was discovered by Mr. S. H. Gilson, of Salt Lake City, and the name of gilsonite was bestowed upon the mineral in his honor. It is generally so known in commerce, as the Gilson Asphaltum Company of Saint Louis, which operates the deposits, places it on the market under that name. Mineralogists, however, prefer to treat it under the name of uintite, given it by Professor W. P. Blake in the first article published on the subject, from the producing locality, near the Uintah mountains. The gilsonite deposits in Utah lie in the northeastern part of the territory, near Fort Duchesne, and just east of the Uintah Indian reservation. Other fine deposits exist in the Uncompahgre Ute reservation, a short distance from the Colorado state line. During the last session of Congress an unsuccessful effort was made to open to settlement the land on which these deposits lie, which is that known as the "Twelve-Mile strip", embracing two rows of townships on the bank of White river. The mineral is found in veins having nearly a perpendicular dip, and are said to be of good thickness and in a position to be easily mined.

Near the locality from which gilsonite is obtained is a deposit of another peculiar form of bitumen, to which Professor Blake has given the name of wurtzilite. This mineral occurs in Wasatch county, Utah, between Salt Lake City and the Green River valley. When first discovered it was thought that a mineral form of caoutchouc had been found, but this was soon disproved by tests showing that it had no tensile elasticity and would not yield to the usual dissolving agents. It was then classed as a species of elaterite; but Dr. Henry Wurtz, after a thorough investigation, has shown it to be an entirely different mineral. No wurtzilite was mined commercially during the calendar year 1889.

Another species of bitumen, ozocerite, found near the town of Thistle, Utah, is very nearly related in composition, color, and physical properties to artificially prepared paraffin, but differs so widely from asphaltum that it is treated under a separate chapter.

Although for a number of years asphaltum in different forms has been known to exist in California in large quantities, it was not until 1888 that its production assumed any important proportions as an industry. In 1888 a large deposit of bituminous rock containing an unusually large percentage of asphaltum was discovered in Ventura county, and a company of San Francisco capitalists was organized for the purpose of developing and operating it. The owners styled this mineral "asphaltum", but as it contains but 24 per cent of bitumen, the other constituents being silica (about 64 per cent), oxide of iron, and calcium carbonate, it should be classed among the bituminous rock products, and is so treated in the tables of this report. Its high percentage of bitumen, however, increases its value, and the price ranges from $8 to $10 per ton, while the bituminous rock of San Luis Obispo and Santa Cruz counties is valued at about $2.50 per ton at the mines. Deposits of a nature similar to the Ventura product are also being operated in Santa Barbara county.

There are several deposits of bituminous rock in San Luis Obispo and Santa Cruz counties, and a number of companies are now engaged in its production. The peculiar features of asphaltum formations are strikingly illustrated in the deposits of California. It is clearly shown that they belong to no particular era or age. They are found at various altitudes, and with no uniform character in appearance, hardness, or chemical composition. Deposits of solid asphaltum and springs of viscid, oily material, commonly called "brea", occur in places not 1,000 feet apart, and yet in strata of unquestionably different periods of formation.

## PRINCIPAL SOURCES OF THE WORLD'S SUPPLY.

Until the remarkable impetus given to the asphaltum industry in California and Utah in 1888 the island of Trinidad and the deposits of Seyssel, in France, and Val-de-Travers, in Switzerland, furnished the bulk of the world's supply. Cuba produces asphaltum of excellent quality, some of which has been imported into the United States. Venezuela has furnished a small portion of the supply in the past, and a few tons of bituminous limestone are imported annually from Germany and the island of Sicily. In the state of Tabasco, Mexico, large deposits of asphaltum are reported, but, although at a convenient place for shipment over the Mexican National railway, only a few small lots have been shipped.

## ASPHALT AS A STREET PAVEMENT.

There are few subjects which have been more liberally discussed than that of street paving. Much study has been given to the subject and many comparative tests have been made, but it is not easy to decide which one of the various kinds used in the larger cities affords at the same time the smoothest travel, most durability, and greatest comfort and safety to horses. There is no doubt that asphalt pavements have some advantage over others; they are smooth, and consequently easy on vehicles, and are fairly durable. Asphalt pavements have been used in European cities for a number of years, and are now in use in over 50 cities in the United States, Buffalo (New York) and Washington (District of Columbia) being conspicuous examples.

The methods of preparing the various asphaltums are in a manner similar yet sufficiently distinct to justify a brief description of each process.

## PROCESSES OF PREPARATION.

The bituminous limestone of France and Switzerland is prepared for street pavements by being first ground to a fine powder, then passed through iron cylinders, into which air, heated to a temperature of 500° fahrenheit, is introduced. It is thoroughly stirred as it passes through the cylinder and, when it reaches the opposite end, is removed in a plastic condition and spread upon a concrete foundation, compacted by rammers, and when cool the street is ready for use.

The Trinidad asphaltum, upon being unloaded at its point of destination, is placed in large tanks and heated over a slow fire for a few days, care being taken not to heat the mass sufficiently to cause distillation. By this process all foreign substances are eliminated; vegetable impurities rise to the top and are skimmed off, while the earthy contents (clay and sand) settle to the bottom, and the asphaltum is then in a condition for manufacture. For street paving the refined asphaltum is treated with a residuum of petroleum and mixed with fine, sharp sand in the proportion of 14 per cent by weight or 25 per cent in bulk of asphaltum. The mixing is thorough, and is made at a temperature of about 300° fahrenheit. While still hot and plastic it is spread upon the foundation already prepared and rolled by heavy steam rollers. The advantage claimed for this asphalt over the French and Swiss limestone material lies chiefly in the granular nature of the sand used in preparing it, which prevents the slipping of horses.

Gilsonite is prepared for this purpose by being first pulverized and mixed with petroleum oil. The mixture is then heated, care being taken to keep the temperature below 500° fahrenheit, as above that temperature gilsonite will decompose. This composite is mixed, while heated, with broken stone or gravel, and is then ready for the street. It has been ascertained that a mixture of about 80 per cent gravel makes the most durable pavement.

For the manufacture of street paving from the bituminous rock of Ventura and Santa Barbara counties, California, it is only necessary to mix it when heated with the sand of the locality where it is used. Sand is mixed with the asphaltum in the proportion of from 3 to 8 times by bulk of sand to 1 of asphaltum. This method effects a considerable saving in transportation expenses. There is no appreciable loss of time in placing it on the street, as it requires only an hour after laying to "set" and be ready for traffic. Once properly mixed and laid, it seems practically indestructible, as shown by a section of this pavement which had been in use for 18 months on one of the streets of San Francisco in the line of heaviest traffic.

The bituminous rock of San Luis Obispo and Santa Cruz counties is a sandstone thoroughly impregnated with bitumen. It is used almost entirely for street paving, and for that purpose is probably more easily and cheaply prepared than any of the asphaltum products. The only treatment necessary is to steam it, so as to thoroughly mix its ingredients and soften it for spreading to a uniform thickness and a smooth, even surface. Bituminous rock has supplied a limited local demand for 10 or 15 years, but it is only during the past 2 years that it has assumed any commercial importance as an industry. It is reported that pavements made of this material 15 years ago and used under heavy travel have recently been removed and found to have lost very little either in weight or thickness; also that it stands equally well the high temperatures of the interior cities and the cold, damp atmosphere of the coast. It is estimated that there are now 50 miles of bituminous-rock street pavement in the state of California.

## FREIGHT RATES, ETC.

Although the production of bituminous rock in California and of gilsonite in Utah has assumed proportions of commercial importance, with indications of much greater activity in the near future, the island of Trinidad continues to be the main source of supply for the United States. In the eastern cities Trinidad asphaltum is used for street paving to the almost entire exclusion of other kinds. This is due entirely to the advantage it has in cost of transportation. The railroad freight rates from the Pacific coast practically shut out the bituminous rock of California from competition in the eastern states, and a similar condition may be said to affect the sale of Trinidad asphaltum in the cities of Europe, since the bituminous limestones of Val-de-Travers and Seyssel, having the advantage in freights, control the markets. The cost of preparing the different varieties of asphaltum for street pavement is nearly the same, and as all appear to be about equally durable, the exclusive use of any one of them is due merely to the advantage in freights.

## COMPARATIVE PRICES.

The following statement shows the ruling prices for the different varieties of asphaltum during the year 1889:

### PRICES OF ASPHALTUM IN 1889.

| | PER TON. |
|---|---|
| Trinidad crude, at New York | $13.00 |
| Trinidad refined, at New York | 30.00 |
| Hard Cuban, at New York | 28.00 |
| Gilsonite, at Saint Louis | 60.00 |
| California bituminous rock, at the mines | $2.50 to 10.00 |
| Kentucky bituminous rock, at the mines | 2.40 |
| | CENTS PER POUND. |
| Prime Cuban, at New York | 4.5 to 5.5 |

## OTHER USES.

Although the greatest use for asphaltum is in the manufacture of street paving, it is by no means confined to that field. Large quantities are consumed in making floors for warehouses, cellars, wineries, breweries, etc. It renders the floors absolutely water tight, and is not affected by acids or gases. For lining dams, levees, and reservoirs a thin coat of asphaltum put on in a melted state presents a permanent water-tight surface, preventing loss by seepage, even when backed by only an earth embankment. As a coating for piling, wharf timbers, ground ends of telegraph poles, etc., it gives almost absolute protection against not only the action of air and water, but also the destructive work of insects and barnacles. It is used as a cement for sea walls and other marine architecture, where its waterproof character makes it especially valuable as a binding material. It is claimed to make wood conduits almost, if not quite, as durable as iron, and any iron or other metal work, such as anchors, etc., coated with it will not rust nor be affected by sea water. It is also used as a roofing material, and, being practically a nonconductor of electricity, serves a useful purpose as an insulator for electrical wires. Varnish is manufactured from refined asphaltum or gilsonite by simply heating with spirits of turpentine.

## NEW DISCOVERIES.

Asphaltum deposits have been found in some of the northwestern counties of Alabama, and some progress has been made in the way of developing the properties, but none of the mineral had been mined up to the close of the year 1889. Other deposits are reported in Grayson and Hardin counties, Kentucky, on which partial developments have been made, but the owners are waiting a more lucrative demand. In Burnet county, Texas, asphaltum is known to exist, but little authentic information is obtainable regarding its extent and character.

## IMPORTS.

The increased demand for asphaltum during the past 20 years is shown by the quantities imported and entered for consumption in the United States during that time.

### ASPHALTUM IMPORTED INTO THE UNITED STATES FROM 1867 TO 1889.

| YEARS ENDED— | Quantity. (Short tons.) | Value. (*a*) |
|---|---|---|
| June 30, 1867 | .............. | $6, 268 |
| 1868 | 185 | 5, 632 |
| 1869 | 203 | 10, 559 |
| 1870 | 488 | 13, 072 |
| 1871 | 1, 301 | 14, 760 |
| 1872 | 1, 474 | 35, 533 |
| 1873 | 2, 314 | 38, 298 |
| 1874 | 1. 183 | 17, 710 |
| 1875 | 1, 171 | 26, 006 |
| 1876 | 807 | 23, 818 |
| 1877 | 4, 532 | 36, 550 |
| 1878 | 5, 476 | 35, 932 |
| 1879 | 8, 084 | 39, 635 |
| 1880 | 11, 830 | 87, 889 |
| 1881 | 12, 883 | 95, 410 |
| 1882 | 15, 015 | 102, 698 |
| 1883 | 33, 116 | 149, 999 |
| 1884 | 36, 078 | 145, 571 |
| Dec. 31, 1885 | 18, 407 | 88, 087 |
| 1886 | 32, 565 | 108, 528 |
| 1887 | 30, 808 | 95, 735 |
| 1888 | 36, 494 | 84, 045 |
| 1889 | 61, 952 | 138, 163 |

*a* Values are given for Trinidad asphaltum at the point of production. The prices at New York, freights included, are given in the previous table.

Acknowledgments are due to Captain F. V. Greene, of New York city, for the following valuable information regarding the importation of asphaltum from Trinidad and other foreign sources. In the statements given below the figures relating to Trinidad asphaltum were obtained by Captain Greene from the records of the company of which he is vice president, while those relating to imports from other sources are estimates made by him based upon his intimate knowledge of the business. Though not derived from any positive records, they are practically correct.

### IMPORTS OF TRINIDAD ASPHALTUM BY ALL COMPANIES FROM 1880 TO 1890, INCLUSIVE.

| | LONG TONS. |
|---|---|
| 1880 | 3, 913 |
| 1881 | 6, 707 |
| 1882 | 14, 263 |
| 1883 | 23, 309 |
| 1884 | 19, 630 |
| 1885 | 15, 289 |
| 1886 | 27, 757 |
| 1887 | 26, 593 |
| 1888 | 35, 137 |
| 1889 | 52, 881 |
| 1890 | 54, 692 |
| Total | 280, 171 |

## CUBA.

About 800 tons of asphaltum were imported from Cuba in 1881 and 1882, but there have been no importations of any consequence since 1882.

## VENEZUELA.

During 1885 and 1886 about 500 tons were obtained from Venezuela, but no amount of any importance has been imported into this country from there since that time.

From Neuchatel, Switzerland, and Seyssel, France, the imports of bituminous limestone, sometimes called "asphalte", are about 200 tons annually, and about 150 tons of a similar material are imported each year from Hanover and Brunswick, Germany. All of this material was used in laying sidewalks and for interior work. During 1887, 1888, 1889, and 1890 about 6,000 tons of bituminous limestone were imported from Sicily and used for street paving.

## PAVEMENTS OF TRINIDAD ASPHALTUM.

The number of square yards of Trinidad asphaltum laid in the United States in the past decade is as follows:

NUMBER OF SQUARE YARDS OF TRINIDAD ASPHALT PAVING LAID IN THE UNITED STATES FROM 1880 TO 1890, INCLUSIVE.

| | SQUARE YARDS. |
|---|---|
| 1880 | 106,838 |
| 1881 | 116,629 |
| 1882 | 196,184 |
| 1883 | 387,510 |
| 1884 | 424,524 |
| 1885 | 403,882 |
| 1886 | 623,188 |
| 1887 | 799,335 |
| 1888 | 757,101 |
| 1889 | 1,130,863 |
| 1890 | 1,857,000 |
| Total | a6,803,054 |

a Equivalent to 446 miles of roadway 26 feet wide.

Trinidad asphaltum is being used for street paving in the following 49 cities in the United States and Canada:

CITIES WHERE TRINIDAD ASPHALT PAVEMENTS ARE USED.

| | |
|---|---|
| District of Columbia | Washington and Georgetown. |
| Georgia | Savannah. |
| Illinois | Chicago. |
| Indiana | Fort Wayne and Indianapolis. |
| Kansas | Topeka, Wichita, and Wyandotte. |
| Kentucky | Louisville. |
| Louisiana | New Orleans. |
| Maryland | Baltimore. |
| Massachusetts | Boston. |
| Michigan | Detroit. |
| Minnesota | Saint Paul. |
| Missouri | Kansas City, Saint Joseph, and Saint Louis. |
| Nebraska | Omaha. |
| New Jersey | Newark. |
| New York | Albany, Binghamton, Brooklyn, Buffalo, Lockport, Long Island City, New York, Rochester, Schenectady, Syracuse, Troy, and Utica. |
| Ohio | Cincinnati, Cleveland, Columbus, Toledo, and Youngstown. |
| Pennsylvania | Allegheny, Altoona, Erie, Harrisburg, Philadelphia, Pittsburg, Scranton, and Wilkesbarre. |
| Tennessee | Chattanooga. |
| Canada | Montreal, Quebec, and Toronto. |

## PERCENTAGE OF USES FOR TRINIDAD ASPHALTUM.

From the best information obtainable, the proportions of Trinidad asphaltum used for different purposes are about as follows:

PROPORTIONS OF USES OF TRINIDAD ASPHALTUM.

| | PER CENT. |
|---|---|
| For laying sheet asphalt pavements | 72 |
| For manufacturing asphalt blocks and tiles for pavements | 24 |
| Total for paving | 96 |
| For roofing | 3 |
| For all other purposes | 1 |
| Total | 100 |

The amount of asphalt blocks manufactured and laid as pavements has varied from 5,000 to 100,000 square yards per annum, and the total from 1880 to 1890, inclusive, is estimated at 500,000 square yards.

## PAVEMENTS FROM BITUMINOUS LIMESTONE.

About 55,000 square yards of bituminous limestone pavement were laid in Washington, District of Columbia, during 1876 and 1877, and about 3,000 square yards in New York in 1883 or 1884. Nearly all of this was subsequently taken up and replaced by Trinidad asphaltum. In 1887 about 10,000 square yards were laid in Rochester, New York; in 1888 about 20,000 square yards in Saint Augustine, Florida, and, in 1890, 40,000 square yards in New York city. Captain Greene estimates that the total amount of bituminous limestone pavement now in use in the United States does not exceed 75,000 square yards.

## ASPHALT PAVEMENTS IN EUROPEAN CITIES.

The asphalt pavements in Europe are all made from the bituminous limestones obtained from the localities mentioned previously in this report. The pavements are found in Berlin, London, Paris, and a few other cities, probably not exceeding 10 in all. The total area covered is, approximately, as follows, according to the authorities cited, and it is about one-fourth of that covered by Trinidad asphalt pavements in the United States:

AREAS OF BITUMINOUS LIMESTONE PAVEMENTS IN USE IN EUROPEAN CITIES.

| | SQUARE YARDS. |
|---|---|
| Berlin | [a] 681, 486 |
| London | [b] 360, 000 |
| Paris | [c] 357, 360 |
| Other cities | [d] 300, 000 |
| Total | 1, 698, 846 |

[a] United States Consular Reports, No. 120.

[b] Reports of paving companies.

[c] Annuaire Statistique de la Ville de Paris, 1883, page 26.

[d] Estimated.

# OZOCERITE.

# OZOCERITE.

BY E. W. PARKER.

Under the chapter on asphaltum mention is made of one of the forms of bitumen possessing such peculiar properties as to entitle it to treatment under a separate head. This is what is known as "mineral wax", or ozocerite. Asphaltum exists in a number of forms, from semiliquid to solid, having qualities similar to pitch or tar, but without any constant chemical composition, and its varieties are as numerous as the localities producing it. Ozocerite, on the other hand, belongs to the series of hydrocarbon compounds which includes marsh gas, petroleum, and paraffin. To the last mentioned it is very similar in appearance. It is colorless to white when pure, but frequently occurs leek green, yellow, and brown.

## SOURCES OF SUPPLY.

Prior to 1888 the only locality producing mineral wax was in the province of Galicia, in Austria. Mining began there in 1862, and though at first it was found exceedingly difficult to obtain sufficient capital to push the enterprise, it has increased rapidly since that date, and at present there are 35 companies engaged in the industry in the province of Galicia alone. For 26 years production was limited to this locality, but in 1888 American ozocerite began to receive the attention of the trade, and considerable work was begun upon a newly discovered vein in Utah. The mineral had been known to exist in Utah for some years, but whether in paying quantity was not satisfactorily determined until August, 1888.

## PRODUCTION.

During 1888 and 1889 most of the work done was in the way of development, but in the latter year there were incidentally produced 75,000 pounds of crude ozocerite. Of this product about one-third is lost in refining, the amount of refined ozocerite being 50,000 pounds, valued at $2,500. The product for 1888 was estimated at 65,000 pounds of crude mineral. The figures regarding expenses and capital for 1889 are withheld from publication for the protection of individual interests. The product for 1890 will probably exceed 300,000 pounds.

## USES.

Refined ozocerite is used for nearly all the purposes to which ordinary beeswax is applicable. It possesses nearly all the properties of beeswax except stickiness, but in cases where that quality is essential it is necessary only to mix the mineral with ordinary beeswax. The uses of beeswax are so many and at the same time so well known that it is not considered necessary to discuss them in this report. Crude ozocerite, like other hydrocarbon compounds, is used to a considerable extent as an insulator for electrical wires.

## IMPORTS.

The following table shows the quantity and value of crude and refined ozocerite imported into the United States from 1873 to 1889, inclusive:

IMPORTS OF MINERAL WAX, 1873 TO 1889, INCLUSIVE. (*a*)

| YEARS ENDED— | Quantity. (Pounds.) | Value. |
|---|---|---|
| June 30, 1873 | 25,135 | $4,244 |
| 1874 | 380 | 40 |
| 1875 | 7,430 | 1,026 |
| 1876 | 16,525 | 2,229 |
| 1877 | 101,604 | 11,720 |
| 1878 | 69,884 | 7,870 |
| 1879 | 44,963 | 6,016 |
| 1880 | 103,973 | 14,057 |
| 1881 | 98,911 | 12,792 |
| 1882 | 272,509 | 29,322 |
| 1883 | 565,658 | 52,774 |
| 1884 | 617,992 | 69,026 |
| 1885 | 1,056,438 | 123,976 |
| Dec. 31, 1886 | 800,496 | 71,220 |
| 1887 | 718,769 | 59,084 |
| 1888 | 1,164,940 | 89,131 |
| 1889 | 1,078,725 | 86,682 |

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[a] Up to and including 1883 imported under "wax, and manufactures of" and classed as "bay or myrtle, Brazilian and Chinese". since as "mineral wax".

# STONE.

# STONE

BY WILLIAM C. DAY.

## SUMMARY.

The subdivisions treated as embracing the subject of stone are slate, marble, granite, sandstone, bluestone, and ordinary limestone, which is the commercial classification. This classification is adopted in preference to the purely scientific one as being more suitable for the purposes of the census. (*a*)

The value of all kinds of stone reported for the Eleventh Census is $53,035,620, distributed as follows: granite, $14,464,095; marble, $3,488,170; sandstone, $10,816,057; bluestone, $1,689,606; slate, $3,482,513; limestone, $19,095,179. The number of quarries operated is given as 4,163, with 82,374 employés, at an expenditure for wages of $30,555,877 and $10,216,926 for supplies, materials, and other expenditures, making a total of $40,772,803. The total capital invested is reported as $90,212,433, distributed as follows: in land, $53,835,548; buildings, fixtures, etc., $10,818,309; tools, implements, etc., $14,528,553; in cash, $11,030,023. Compared with the Tenth Census, these figures show a wonderful growth of the stone industry throughout the United States.

It should be distinctly understood that the quantity of each kind of stone reported is limited to the product actually quarried and sold. It does not include either material quarried but not utilized nor the stone used by private individuals and not regularly sold. The value is the actual amount obtained by the quarrymen in the condition in which the stone first became a commercial article. The limestone, etc., for example, used for decorative purposes was valued at the price received for that purpose, while the product which was burned into lime was of correspondingly less value.

In collecting the statistics of stone in the United States it was thought best to subdivide the kinds of stone in accordance with commercial usages, thus serving the interests of the producers more perfectly than would be compatible with a strictly scientific classification. It is true, however, that there is no such great difference between the commercial and scientific classifications as would in any degree be detrimental to scientific interests, so that the latter have been observed as well as those of the quarrymen.

The subdivisions made are as follows: granite, marble, ordinary limestone, sandstone, bluestone, and slate. The scientific subdivisions which would most naturally suggest themselves are slate, limestone (including marble), crystalline siliceous rocks, and sandstone (including bluestone and grindstones). It appears, then, that in the classification herein adopted 6 subjects have been treated, rather than 4, as the strictly scientific classification would require.

The separation of limestone into ordinary limestone and marble was made because of the great diversity in the commercial interests of the 2 classes of producers involved consequent upon the very different uses to which ordinary limestone and marble are put. Scientifically, also, the distinction between ordinary limestone and marble is very definite and satisfactory, the dividing line being determined by the generally less pure and noncrystalline character of ordinary limestone and the pure homogeneous and crystalline constitution of marble, which, by processes of metamorphism, has been produced by change in structure from ordinary limestone.

The term "granite" as used would, from the scientific standpoint, be more properly substituted by the more comprehensive term "crystalline siliceous rocks", but from the commercial point of view "granite" is better, as being in common use; and the great bulk of the stone reported herein as granite is really true granite of one or other of the various subvarieties.

The following table, arranged according to kinds of stone, gives various totals for all of these kinds of stone in the United States. It is evident that the figures for limestone in all cases are decidedly greater than the corresponding figures for any other kind. Granite, in point of magnitude, stands second; sandstone, third; marble, fourth; slate, fifth, and bluestone sixth. The table shows that the total value of the stone product of the United States for 1889 is $53,035,620; that it was produced from 4,163 quarries by 82,374 employés, to whom were paid $30,555,877 in

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*a* Special acknowledgments are due to Mr. C. H. Hardon, special agent, for services as chief clerk during the preparation of the directory of stone producers; to Mr. J. H. Humphries for services as chief clerk; to Mr. W. B. Smith for his field notes, particularly in New England, and his aid in tabulation; to Mr. Morris Ebert as consulting expert on stone from the commercial standpoint and for aid in collecting the data on bluestone, and to Mr. Eugene Leamy for services in the field and in the preparation of diagrams and maps.

wages. The total expense of producing the various products amounts to $40,772,803, thus leaving a profit of $12,262,817 to the producers. The total capital invested amounts to $90,212,433. In 1880 the total number of quarries reported was 1,525, the value of the output was $18,356,055, and the capital invested was $25,414,497, so that the industry appears to be at present, approximately, three times as great. This fact alone would indicate that the work has been done with a great degree of thoroughness.

In connection with bluestone, it should be borne in mind that the figure $1,689,606, representing the total value of the bluestone output, represents the value of stone regularly taken from definitely organized quarries, and also the amount which was purchased by wholesale dealers from men whose operations are irregular and scattering, and from whom no definite statistics as to labor, expenses, power, and capital could be obtained. The reason for this is given in detail in the report on bluestone. The value of the stone taken from the 217 bluestone quarries given in the table is $749,912. The statistics as to labor, expense, power, and capital invested given for bluestone apply only, therefore, to the 217 regularly operated bluestone quarries.

RÉSUMÉ OF STATISTICS OF STONE PRODUCT IN THE UNITED STATES IN 1889.

| KINDS OF STONE. | Number of quarries. | Total value. | LABOR—AVERAGE NUMBER OF EMPLOYÉS. | | | | | | | EXPENSES. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Total number employed. | Foremen. | Quarrymen. | Mechanics. | Laborers. | Boys under 16 years. | Office force. | Total expenses. | Wages. | Supplies and materials. | Other expenditures. |
| Total | 4, 163 | $53, 035, 620 | 82, 374 | 3, 590 | 40, 386 | 12, 017 | 23, 814 | 1, 481 | 1, 086 | $40, 772, 803 | $30, 555, 877 | $7, 923, 220 | $2, 293, 706 |
| Granite | 874 | 14, 464, 095 | 22, 313 | 815 | 10, 006 | 6, 585 | 4, 342 | 343 | 222 | 11, 504, 021 | 9, 620, 485 | 1, 446, 485 | 437, 051 |
| Marble | 103 | 3, 488, 170 | 4, 529 | 158 | 2, 185 | 1, 021 | 1, 013 | 56 | 96 | 2, 675, 069 | 1, 809, 211 | 655, 586 | 210, 272 |
| Limestone | 1, 954 | 19, 095, 179 | 30, 644 | 1, 470 | 16, 420 | 2, 037 | 9, 825 | 459 | 433 | 15, 092, 714 | 10, 121, 985 | 4, 227, 246 | 743, 483 |
| Sandstone | 803 | 10, 816. 057 | 16, 925 | 782 | 7, 746 | 1, 983 | 5, 912 | 250 | 252 | 8, 130, 295 | 6, 257, 580 | 1, 277, 004 | 595, 711 |
| Bluestone | 217 | 1, 689, 606 | 1, 793 | 144 | 778 | 109 | 736 | 18 | 8 | 608, 582 | 527, 634 | 34, 785 | 46, 163 |
| Slate | 212 | 3, 482, 513 | 6, 170 | 221 | 3, 251 | 282 | 1, 986 | 355 | 75 | 2, 762, 122 | 2, 218, 982 | 282, 114 | 261, 026 |

| KINDS OF STONE. | POWER. | | | | CAPITAL INVESTED. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of boilers. | Total horse power of boilers. | Horse power of water wheels. | Number of animals employed. | Total capital. | Land. | Buildings and fixtures. | Tools, implements, etc. | Cash. |
| Total | 2, 544 | 72, 209 | 4, 297 | 14, 089 | $90, 212, 433 | $53, 835, 548 | $10, 818, 309 | $14, 528, 553 | $11, 030, 023 |
| Granite | 556 | 15, 119 | 80 | 2, 980 | 19, 115, 449 | 10, 897, 417 | 1, 580, 784 | 3, 731, 078 | 2, 906, 170 |
| Marble | 206 | 8, 022 | 3, 370 | 693 | 15, 092, 842 | 8, 828, 960 | 2, 130, 415 | 1, 876, 265 | 2, 257, 202 |
| Limestone | 926 | 21, 945 | 417 | 6, 982 | 27, 022, 325 | 14, 771, 200 | 4, 988, 207 | 4, 541, 623 | 2, 721, 295 |
| Sandstone | 553 | 15, 182 | 165 | 2, 851 | 17, 776, 467 | 11, 501, 100 | 1, 492, 850 | 3, 044, 557 | 1, 737, 960 |
| Bluestone | 12 | 169 | ............ | 183 | 635, 757 | 428, 380 | 17, 015 | 106, 292 | 84, 070 |
| Slate | 291 | 11, 772 | 265 | 400 | 10, 569. 593 | 7, 408, 491 | 609, 038 | 1, 228, 738 | 1, 323, 326 |

The following table shows the value of the total product and also the total capital invested in all kinds of stone in the 5 general divisions of the United States (*a*):

VALUE OF PRODUCT OF ALL KINDS OF STONE AND CAPITAL INVESTED IN THE INDUSTRY.

| DIVISIONS. | Value of product. | Capital invested. |
|---|---|---|
| Total | $53, 035, 620 | $90, 212, 433 |
| North Atlantic | 27, 799, 838 | 44, 985, 462 |
| South Atlantic | 3, 195, 399 | 7, 825, 742 |
| North Central | 15, 778, 104 | 25, 562, 919 |
| South Central | 1, 588, 960 | 2, 341, 594 |
| Western | 4, 673, 319 | 9, 496, 716 |

*a* The states included in these divisions are as follows:

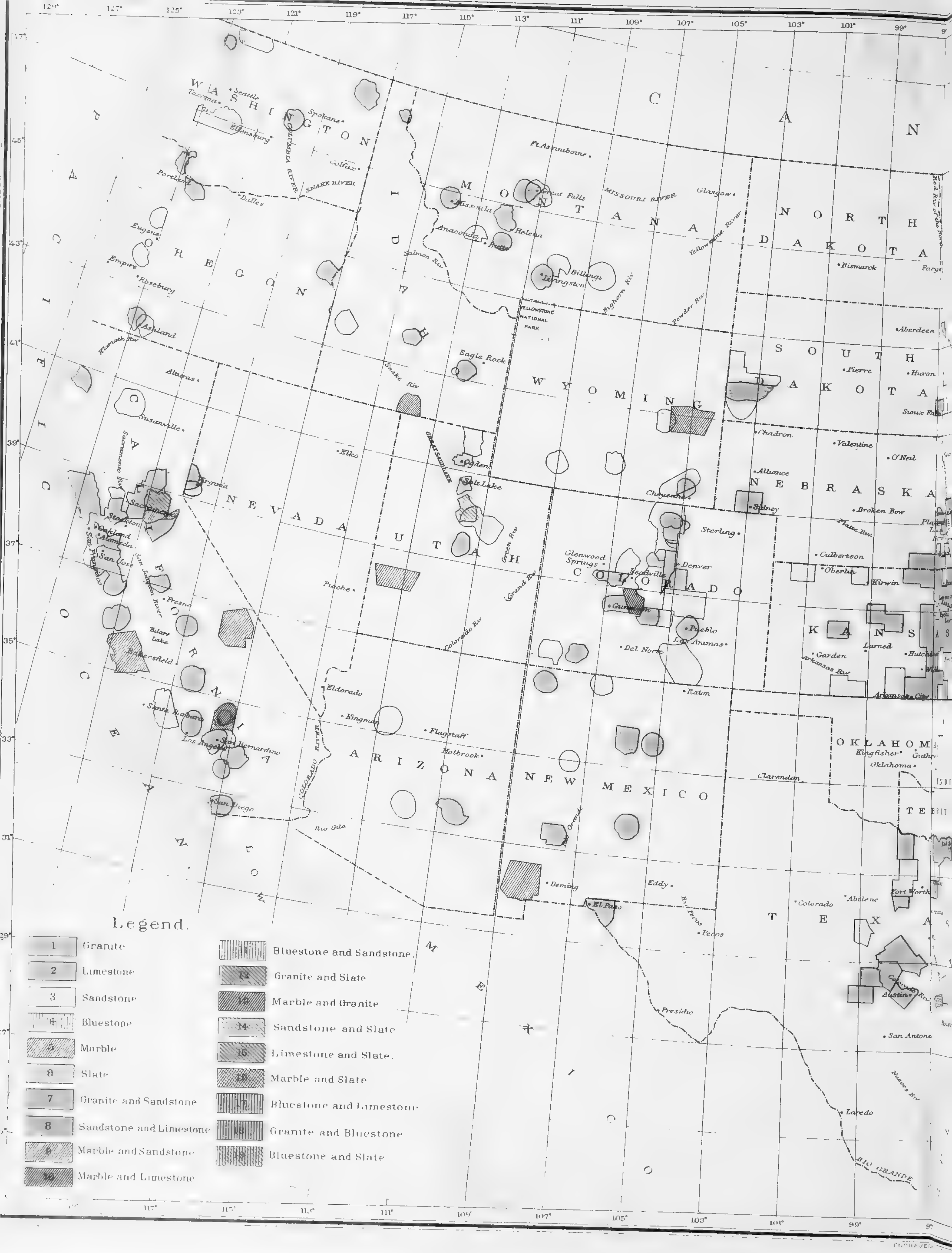
NORTH ATLANTIC DIVISION.—Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania.

SOUTH ATLANTIC DIVISION.—Delaware, Maryland, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida.

NORTH CENTRAL DIVISION.—Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, South Dakota, Nebraska, Kansas.

SOUTH CENTRAL DIVISION.—Kentucky, Tennessee, Alabama, Texas, Arkansas.

WESTERN DIVISION.—Montana, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Idaho, Washington, Oregon, California.


Legend.
1 Granite
2 Limestone
3 Sandstone
4 Bluestone
5 Marble
6 Slate
7 Granite and Sandstone
8 Sandstone and Limestone
9 Marble and Sandstone
10 Marble and Limestone
11 Bluestone and Sandstone
12 Granite and Slate
13 Marble and Granite
14 Sandstone and Slate
15 Limestone and Slate
16 Marble and Slate
17 Bluestone and Limestone
18 Granite and Bluestone
19 Bluestone and Slate
PACIFIC OCEAN
CANADA
WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
COLORADO
ARIZONA
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MEXICO
Seattle
Tacoma
Spokane
Ellensburg
Colfax
Portland
Dalles
Eugene
Empire
Roseburg
Ashland
Klamath Riv
Altaras
Susanville
Virginia
Sacramento
Stockton
Oakland
Alameda
San Francisco
San Jose
Fresno
Tulare Lake
Bakersfield
Santa Barbara
Los Angeles
San Bernardino
San Diego
Elko
Pioche
Eldorado
Kingman
Flagstaff
Holbrook
Rio Gila
Colorado River
Ogden
Salt Lake
Great Salt Lake
Green Riv
Grand Riv
Colorado Riv
Eagle Rock
Snake Riv
Salmon Riv
Missoula
Anaconda
Butte
Helena
Great Falls
Ft Assinniboine
Glasgow
Missouri River
Yellowstone River
Billings
Livingston
Bighorn Riv
Powder Riv
Yellowstone National Park
Columbia River
Snake River
Bismarck
Fargo
Red Riv of the North
Aberdeen
Pierre
Huron
Sioux Falls
Chadron
Valentine
O'Neil
Alliance
Sidney
Broken Bow
Platte Riv
Cheyenne
Sterling
Denver
Glenwood Springs
Leadville
Gunnison
Pueblo
Las Animas
Del Norte
Raton
Culbertson
Oberlin
Kirwin
Larned
Garden
Arkansas Riv
Arkansas City
Hutchinson
Kingfisher
Guthrie
Oklahoma
Clarendon
Rio Grande
Deming
Eddy
El Paso
Rio Pecos
Pecos
Colorado
Abilene
Fort Worth
Austin
Colorado Riv
Presidio
San Antonio
Nueces Riv
Laredo
RIO GRANDE
47°
45°
43°
41°
39°
37°
35°
33°
31°
29°
127°
125°
123°
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113°
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107°
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103°
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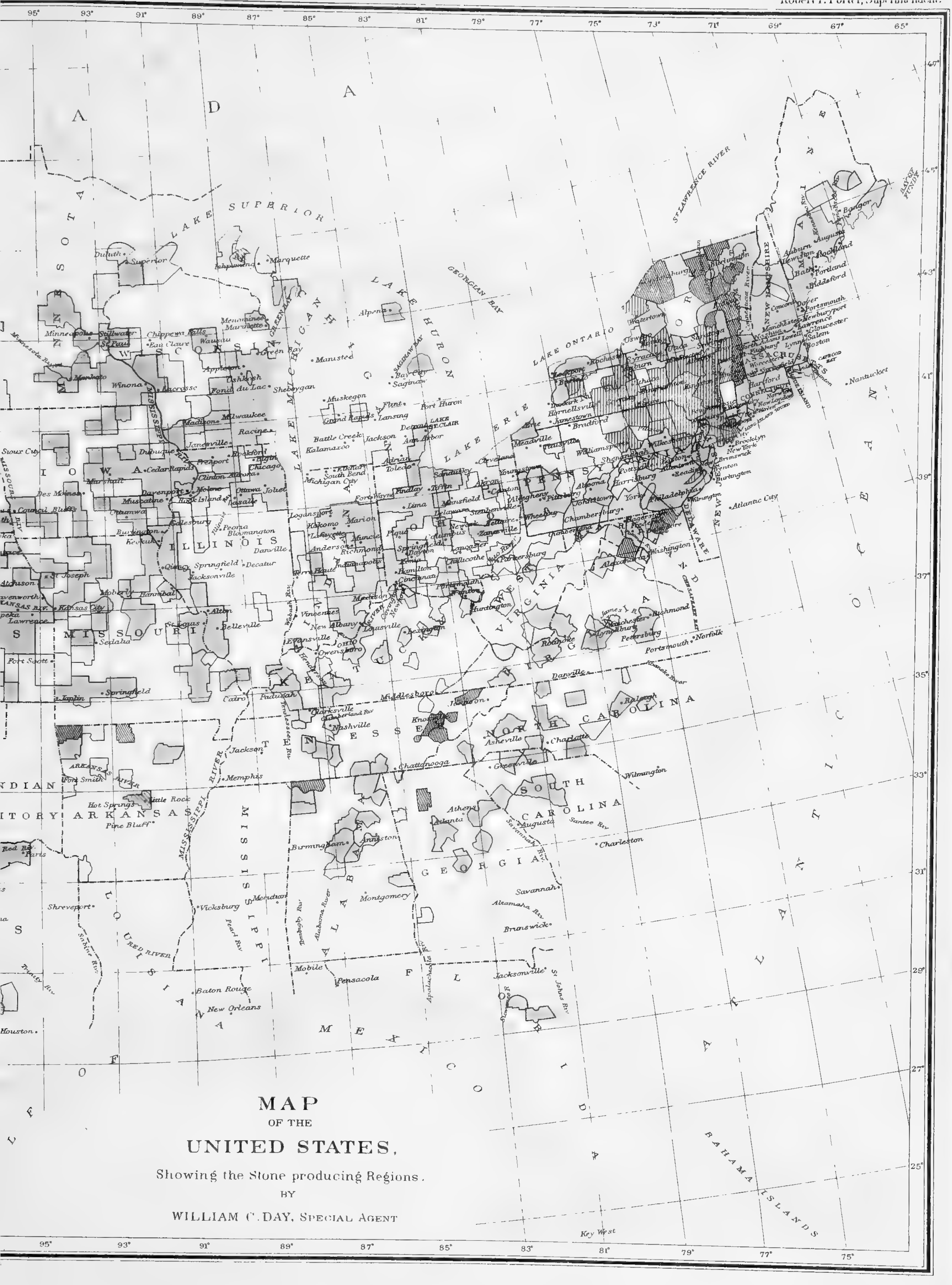
ENGRAVED

Robert P. Porter, Superintendent.



# MAP
OF THE
# UNITED STATES,

Showing the Stone producing Regions.

BY

WILLIAM C. DAY, SPECIAL AGENT

# GRANITE.

Of the various kinds of stone quarried in the United States granite is capable of the widest application when all the uses to which stone is put are considered. This statement applies, of course, not only to uses in which strength, power to resist disintegration, and permanency are essential, but also to those in which natural beauty and susceptibility to ornamentation and high polish are necessarily taken into account.

The purposes to which granite is now applied are much more numerous than they were a comparatively few years ago. The increase in the wealth of the country at large, as well as of individuals, has had much to do with this, especially in connection with uses involving ornamentation and fine finish. The great hardness of the stone and the consequent difficulty with which it is cut and polished make it when entirely finished decidedly expensive. Among wealthy people its costliness frequently determines its selection in preference to other kinds of stone, simply because the high price is an indication that nothing better can be had.

In this report the term "granite" is made to cover a much greater variety of stones than the strictly scientific use of the name would allow; in other words, it is used in its commercial rather than in its scientific sense. At the same time it is true that the great bulk of the granite herein reported is true granite of one subvariety or another. This broad classification is adopted for the purpose of making the report more significant, and consequently more valuable to stone producers, who in their business do not, as a rule, make fine distinctions between one kind of granite and another. Although variations in the nature and proportions of the minerals which constitute the granites have much to do in determining the adaptability of the stone to many purposes, still this fact is not made prominent by granite quarrymen in placing their products on the market. If by actual use a particular granite is found to do well for a certain purpose, it is, in general, correspondingly well received without inquiry as to its special constitution, which in reality determines its adaptability for such purpose.

The following list gives a general idea of the geographical distribution of granite, and indicates most of the particular kinds that have been or are now being quarried in the various localities mentioned:

## GEOGRAPHICAL DISTRIBUTION OF GRANITE.

### ARKANSAS.

| | |
|---|---|
| Hornblende-biotite granite | Pulaski county. |
| Elæolite syenite | Garland county. |

### CALIFORNIA.

| | |
|---|---|
| Biotite granite | Placer county. |
| Hornblende-biotite granite | Placer and Sacramento counties. |
| Hornblende granite | Placer county. |
| Quartz diorite | Placer county. |
| Basalt | Solano, Sonoma, and Alameda counties. |
| Andesite | Shasta county. |
| Andesitic tufa | Solano county. |
| Quartz porphyry | San Bernardino county. |
| Basaltic tufa | Tehama county. |

### COLORADO.

| | |
|---|---|
| Biotite granite | Clear Creek and Jefferson counties. |
| Muscovite gneiss | Clear Creek county. |
| Diorite | Chaffee county. |
| Rhyolite | Chaffee and Conejos counties. |
| Rhyolitic tufa | Douglas county. |
| Basalt | Jefferson county. |

### CONNECTICUT.

| | |
|---|---|
| Biotite granite | Litchfield, New Haven, New London, and Fairfield counties. |
| Muscovite-biotite granite | Litchfield county. |
| Muscovite-biotite gneiss | Litchfield county. |
| Biotite gneiss | Litchfield, New Haven, New London, Windham, Tolland, and Hartford counties. |
| Hornblende-biotite gneiss | Middlesex and Fairfield counties. |
| Diabase | New Haven county. |

### DELAWARE.

| | |
|---|---|
| Augite-hornblende gneiss | Newcastle county. |

### GEORGIA.

| | |
|---|---|
| Muscovite granite | Dekalb county. |
| Hornblende-biotite gneiss | Fulton county. |

### MAINE.

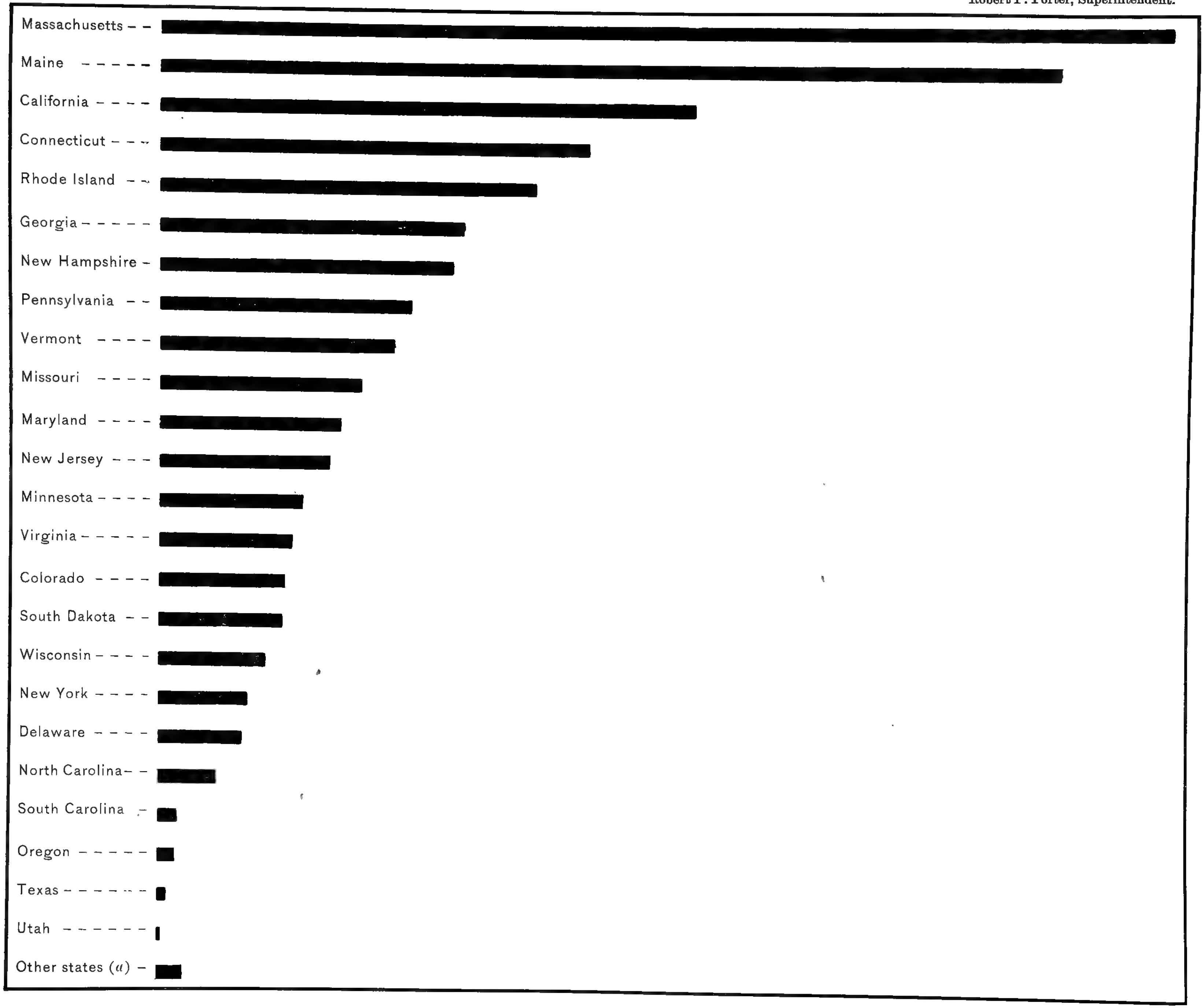
| | |
|---|---|
| Biotite granite | Knox, York, Washington, Lincoln, Waldo, Oxford, Kennebec, and Hancock counties. |
| Biotite gneiss | Lincoln, Franklin, and Androscoggin counties. |
| Muscovite-biotite granite | Kennebec, Waldo, and Franklin counties. |
| Hornblende-biotite granite | Penobscot and Knox counties. |
| Hornblende granite | Hancock county. |
| Olivine diabase | Washington county. |
| Diabase | Washington and Knox counties. |

### MARYLAND.

| | |
|---|---|
| Biotite granite | Baltimore, Howard, and Montgomery counties. |
| Biotite gneiss | Cecil and Baltimore counties. |
| Gabbro | Baltimore county. |

### MASSACHUSETTS.

| | |
|---|---|
| Hornblende granite | Norfolk and Essex counties. |
| Hornblende-biotite granite | Essex county. |
| Epidote granite | Norfolk county. |
| Biotite granite | Norfolk, Middlesex, Bristol, Worcester, and Plymouth counties. |
| Biotite-muscovite granite | Worcester and Berkshire counties. |
| Biotite gneiss | Franklin county. |
| Muscovite gneiss | Middlesex, Essex, Worcester, and Hampden counties. |
| Diabase | Middlesex and Hampden counties. |
| Melaphyre | Suffolk county. |



RELATIVE RANK OF STATES PRODUCING GRANITE.

*a* Arkansas, Montana, Nevada, and Washington.

## GEOGRAPHICAL DISTRIBUTION OF GRANITE—Continued.

### MINNESOTA.

| | |
|---|---|
| Hornblende granite | Sherburne, Benton, and Lake counties. |
| Hornblende-mica granite | Benton county. |
| Quartz porphyry | Lake and Saint Louis counties. |
| Diabase | Saint Louis county. |
| Olivine diabase | Chisago county. |
| Gabbro | Saint Louis county. |

### MISSOURI.

| | |
|---|---|
| Hornblende-biotite granite | Iron and Saint François counties. |
| Granite | Iron county. |
| Olivine diabase | Iron county. |

### MONTANA.

| | |
|---|---|
| Hornblende-mica granite | Lewis and Clarke county. |

### NEVADA.

| | |
|---|---|
| Hornblende andesite | Washoe county. |

### NEW HAMPSHIRE.

| | |
|---|---|
| Biotite-muscovite granite | Merrimack, Cheshire, Hillsboro Grafton, Sullivan, and Strafford counties. |
| Biotite granite | Cheshire, Hillsboro, Grafton, and Rockingham counties. |
| Hornblende-biotite granite | Carroll county. |
| Muscovite-biotite gneiss | Cheshire and Hillsboro counties. |
| Biotite-epidote gneiss | Grafton county. |

### NEW JERSEY.

| | |
|---|---|
| Biotite gneiss | Passaic county. |
| Hornblende granite | Morris county. |
| Diabase | Hudson county. |

### NEW YORK.

| | |
|---|---|
| Biotite granite | Putnam county. |
| Hornblende-mica granite | Jefferson county. |
| Norite | Essex county. |
| Biotite gneiss | Westchester and Rockland counties. |

### NORTH CAROLINA.

| | |
|---|---|
| Biotite granite | Warren, Franklin, Gaston, Granville, Alamance, Davidson, Mecklenburg, Iredell, Forsyth, Guilford, Richmond, and Anson counties. |
| Muscovite granite | Warren county. |
| Granite | Rowan and Orange counties. |
| Biotite-muscovite granite | Rowan county. |
| Hornblende-biotite granite | Mecklenburg county. |
| Biotite gneiss | Cleveland, McDowell, Caldwell, Wilson, Stokes, Iredell, Wake, and Guilford counties. |
| Hornblende gneiss | Burke county. |

### OREGON.

| | |
|---|---|
| Granite | Jackson and Columbia counties. |
| Diabase | Linn county. |
| Basalt | Clackamas and Columbia counties. |
| Andesite | Multnomah county. |

### PENNSYLVANIA.

| | |
|---|---|
| Biotite gneiss | Philadelphia and Delaware counties. |
| Muscovite gneiss | Philadelphia and Berks counties. |
| Biotite-muscovite gneiss | Delaware county. |
| Diabase | Adams, York, Berks, and Lancaster counties. |
| Diorite | Berks county. |
| Hornblende gneiss | Philadelphia county. |

### RHODE ISLAND.

| | |
|---|---|
| Biotite granite | Washington, Kent, and Providence counties. |
| Granite | Washington county. |
| Biotite gneiss | Providence county. |
| Hornblende gneiss | Providence county. |

### SOUTH CAROLINA.

| | |
|---|---|
| Biotite granite | Fairfield, Charleston, Aiken, Lexington, Richland, Edgefield, and Newberry counties. |
| Hornblende-biotite granite | Fairfield county. |

### SOUTH DAKOTA.

| | |
|---|---|
| Granite | Minnehaha county. |

### TEXAS.

| | |
|---|---|
| Biotite granite | Burnet county. |
| Diorite | El Paso county. |

### UTAH.

| | |
|---|---|
| Hornblende-biotite granite | Salt Lake and Weber counties. |

### VERMONT.

| | |
|---|---|
| Biotite granite | Washington and Essex counties. |
| Muscovite granite | Windsor county. |
| Biotite-muscovite granite | Caledonia county. |
| Gabbro. | |

### VIRGINIA.

| | |
|---|---|
| Biotite granite | Dinwiddie, Chesterfield, and Henrico counties. |
| Muscovite granite | Spottsylvania county. |
| Biotite gneiss | Campbell county. |
| Biotite schist | Fauquier county. |
| Diabase | Loudoun and Fauquier counties. |

### WASHINGTON.

| | |
|---|---|
| Granite | Stevens county. |

### WISCONSIN.

| | |
|---|---|
| Granite | Marquette county. |
| Hornblende granite | Marathon county. |
| Quartz porphyry | Green Lake county. |
| Biotite gneiss | Jackson county. |

## PRODUCTION.

The table of production, page 603, shows by states and territories the general condition of the granite industry. Granite was produced in 28 states and territories, 10 more than were included in the Tenth Census report. The total value of the output of the United States in 1889 was $14,464,095, while according to the census of 1880 the total value amounted to $5,188,998, a gain of $9,275,097, or 179 per cent, in the decade.

The following table shows the relative standing, according to value of output, of the various productive states and territories in 1880 and 1889:

RANK OF STATES AND TERRITORIES ACCORDING TO THE VALUE OF GRANITE PRODUCT IN 1880 AND 1889.

| Rank. | TENTH CENSUS. | | Rank. | ELEVENTH CENSUS. | |
|---|---|---|---|---|---|
| | States and territories. | Value of output. | | States and territories. | Value of output. |
| | Total | $5,188,998 | | Total | $14,464,095 |
| 1 | Massachusetts | 1,329,315 | 1 | Massachusetts | 2,503,503 |
| 2 | Maine | 1,175,286 | 2 | Maine | 2,225,839 |
| 3 | Rhode Island | 623,000 | 3 | California | 1,329,018 |
| 4 | Connecticut | 407,225 | 4 | Connecticut | 1,061,202 |
| 5 | Virginia | 331,928 | 5 | Rhode Island | 931,216 |
| 6 | New Hampshire | 303,066 | 6 | Georgia | 752,481 |
| 7 | Maryland | 224,000 | 7 | New Hampshire | 727,531 |
| 8 | Pennsylvania | 211,454 | 8 | Pennsylvania | 623,252 |
| 9 | California | 172,450 | 9 | Vermont | 581,870 |
| 10 | Missouri | 110,000 | 10 | Missouri | 500,642 |
| 11 | New Jersey | 99,000 | 11 | Maryland | 447,489 |
| 12 | Georgia | 64,480 | 12 | New Jersey | 425,673 |
| 13 | Vermont | 59,675 | 13 | Minnesota | 356,782 |
| 14 | Colorado | 41,400 | 14 | Virginia | 332,548 |
| 15 | Minnesota | 13,075 | 15 | Colorado | 314,673 |
| 16 | Delaware | 12,600 | 16 | South Dakota | 304,673 |
| 17 | New York | 10,000 | 17 | Wisconsin | 266,095 |
| 18 | Washington | 1,044 | 18 | New York | 222,773 |
| | | | 19 | Delaware | 211,194 |
| | | | 20 | North Carolina | 146,627 |
| | | | 21 | South Carolina | 47,614 |
| | | | 22 | Oregon | 44,150 |
| | | | 23 | Texas | 22,550 |
| | | | 24 | Utah | 8,700 |
| | | | | Other states (*a*) | 76,000 |

*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Arkansas, Montana, Nevada, and Washington.

It will be seen from the foregoing table that Massachusetts and Maine hold the same relative positions, namely, 1 and 2, that they did in 1880, and that to hold these positions the increase in value of output has been very great. A very notable increase in production has raised California from ninth place in the Tenth Census to third place in the Eleventh. Rhode Island has dropped from third to fifth place, thus putting it below Connecticut, which, by more than doubling its output, maintains fourth place. The production in Virginia has changed but very little in the last 10 years, so that, remaining constant in value of output, its position in the series has dropped from fifth to fourteenth place. In the case of Georgia a very striking increase raises it from twelfth to sixth place, thus placing it 1 position above the "Granite state", New Hampshire. The increase in production in Georgia is largely due to the extensive operations at Stone mountain, near Atlanta, which were begun only a few years ago. Operations in New Hampshire have resulted in an output of more than twice the value of that reported in 1880, but nevertheless it has fallen from sixth to seventh place. It is probable that the output in this state during 1890 will show a decided gain, owing to the fulfillment of a number of extensive contracts for Concord granite which have been recently made. Pennsylvania, by nearly tripling its output, maintains eighth place. The great increase in production in California is due to operations at the Folsom granite quarries. The granite produced at this locality is largely used on the spot in constructing a dam to be utilized by the Folsom Water Power Company. It has also been applied to the construction of a canal and the buildings of the power house of the state prison, located near the quarries. This work was done chiefly by convict labor. In Sonoma county granite is extensively quarried for paving blocks. This stone is really basalt, and has given unmistakable satisfaction for paving purposes. Most of the paving blocks of the state come from this county. Missouri maintains tenth place, but, as compared with the Tenth Census figures, the value of the output is more than quadrupled. This increase is due to extended operations at Graniteville, in Iron county, where a so-called red granite is produced, which has become quite popular in a number of large cities for building purposes. Colorado is in fifteenth place in the Eleventh Census. The growth in this state is due to increased activity in Douglas county, at points 30 to 35 miles south of Denver, where the variety known as rhyolite, commonly called lava stone, is produced. Remarkable activity is evident in Minnesota. The output in 1880 was comparatively insignificant, whereas that for 1889 amounts to nearly $357,000. This notable increase is due chiefly to operations in Sherburne and Stearns counties, in the vicinity of Saint Cloud, and also at Sauk Rapids, in Benton county. Minnesota has made a stride in advance which will probably be permanent. Sixteenth place in the series is now held by South Dakota. Operations in this state date back only a few years, but have developed rapidly. The most important producing locality is Sioux Falls, Minnehaha county, the product being sold under the commercial name of Sioux Falls granite. Indications point to the conclusion that South Dakota will hold its position in the series for some time to come. Although Delaware has fallen from sixteenth to nineteenth place, the increase in the value of production is very remarkable, namely, from $12,600 in 1880 to $211,194 in 1889. New York, with a product of $10,000 in granite in 1880, shows an increase to $222,773 in 1889. No figures for North Carolina appear in previous reports, but at present it holds twentieth place, with an output valued at $146,627. South Carolina and Texas, neither of which appears in previous reports, give indications of promising future developments, although the present output is not great. Arkansas, although holding next to last place in the list of states for 1889, will doubtless show a much greater output in the course of a few years, owing to developments already made in the vicinity of Little Rock of what is known as Fourche Mountain granite, which is, strictly speaking, syenite.

The following table is presented for the sake of comparing the 18 states which were productive in 1880 with those of 1889, from which it appears that 94 per cent of the total value of the product of 1889 is the value of stone taken from the same states reported at the Tenth Census. In other words, the 10 states added during the past decade have contributed only 6 per cent of the value of the total output of the country.

COMPARISON OF GRANITE PRODUCT IN STATES PRODUCTIVE IN 1880 AND 1889.

| STATES. | VALUE OF OUTPUT. | |
|---|---|---|
| | 1889. | 1880. |
| Total | $13,557,686 | $5,188,998 |
| Massachusetts | 2,503,503 | 1,329,315 |
| Maine | 2,225,839 | 1,175,286 |
| Rhode Island | 931,216 | 623,000 |
| Connecticut | 1,061,202 | 407,225 |
| Virginia | 332,548 | 331,928 |
| New Hampshire | 727,531 | 303,066 |
| Maryland | 447,489 | 224,000 |
| Pennsylvania | 623,252 | 211,454 |
| Missouri | $500,642 | $110,000 |
| New Jersey | 425,673 | 99,000 |
| Georgia | 752,481 | 64,480 |
| Vermont | 581,870 | 59,675 |
| Colorado | 314,673 | 41,400 |
| Minnesota | 356,782 | 13,075 |
| Delaware | 211,194 | 12,600 |
| New York | 222,773 | 10,000 |
| California and Washington | 1,339,018 | 173,494 |

From this comparison it is evident that the increase in production of states reported by the Tenth Census amounts to $8,368,688, or 161 per cent. These tables did not include figures pertaining to quarries producing less than $1,000 worth of stone in the census year; and inasmuch as the figures for the present census include all quarries regardless of magnitude, the following statement, showing the aggregates of granite quarries producing in each case less than $1,000 worth in 1889, may be found of interest. It is evident that the total value of stone produced from these minor quarries is small, amounting to only $27,745, or two-tenths of 1 per cent of the total output.

TOTALS FROM GRANITE QUARRIES PRODUCING LESS THAN $1,000 WORTH OF STONE IN 1889.

| STATES. | Value. | Wages. | Total expenses. | Total capital. |
|---|---|---|---|---|
| Total | $27,745 | $24,168 | $29,427 | $107,375 |
| California | 1,750 | 1,325 | 1,526 | 4,690 |
| Colorado | 225 | 280 | 305 | 11,320 |
| Connecticut | 5,367 | 2,485 | 3,102 | 6,950 |
| Delaware | 700 | 300 | 1,008 | 5,920 |
| Georgia | 887 | 2,510 | 2,781 | 3,120 |
| Maine | 9,794 | 6,881 | 8,705 | 24,085 |
| Massachusetts | 2,909 | 1,761 | 2,541 | 11,920 |
| Minnesota | 338 | 1,237 | 1,353 | 3,750 |
| New Jersey | 680 | 3,075 | 3,241 | 6,750 |
| North Carolina | 350 | 110 | 110 | 65 |
| Pennsylvania | 4,745 | 4,204 | 4,755 | 28,805 |

It is noteworthy that the total expenses involved in the production of the granite reported in this table exceed the total value by nearly $2,000. This is accounted for by the fact that many of these small enterprises were new, and probably in many cases short-lived.

## GEOGRAPHICAL DISTRIBUTION.

For convenience, the country may be divided into 3 sections—eastern, middle, and western. The first includes the following states, named in order of the value of the product: Massachusetts, Maine, Connecticut, Rhode Island, Georgia, New Hampshire, Pennsylvania, Vermont, Maryland, New Jersey, Virginia, New York, Delaware, North Carolina, and South Carolina; the middle section includes Missouri, Minnesota, South Dakota, Wisconsin, and Arkansas; the western embraces California, Colorado, Montana, Oregon, Texas, Washington, Utah, and Nevada. From the following table the value of the output of the eastern section is seen to be $11,240,812, or 77.72 per cent of the whole; that of the middle section $1,433,192, or 9.91 per cent of the entire output, and of the western section $1,790,091, or 12.38 per cent. In short, the great bulk of the granite output comes from the vicinity of the eastern coast of the United States. Intermediate between the eastern and middle sections is a continuous belt of states, extending from the northern to the southern boundaries of the United States, which is at present totally unproductive of granite. This section includes the states of Michigan, Iowa, Illinois, Indiana, Ohio, Kentucky, West Virginia, Tennessee, Mississippi, Louisiana, and Alabama.

VALUE OF GRANITE PRODUCED IN THE UNITED STATES IN 1889.

| | |
|---|---|
| Eastern section | $11,240,812 |
| Middle section | 1,433,192 |
| Western section | 1,790,091 |
| Total | 14,464,095 |

Further subdividing the eastern section into 2 portions, northern and southern, the former including only the New England states and the latter all states south of them, it appears that the New England states produced $8,031,161 worth, or 55.52 per cent of the entire output of the country. In 1880 the same states produced 75.11 per cent of the total.

The following table shows the percentage of gain in each of the states, arranged in order of greatest gain, which were productive both in 1880 and 1889:

PERCENTAGE OF INCREASE OF STATES PRODUCING IN 1880.

| | PER CENT. | | PER CENT. |
|---|---|---|---|
| Minnesota | 2,628.73 | New Jersey | 329.97 |
| New York | 2,127.73 | Pennsylvania | 194.75 |
| Delaware | 1,576.14 | Connecticut | 160.59 |
| Georgia | 1,067.00 | New Hampshire | 140.06 |
| Vermont | 875.06 | Maryland | 99.77 |
| Washington | 857.85 | Maine | 89.39 |
| California | 670.67 | Massachusetts | 88.33 |
| Colorado | 660.08 | Rhode Island | 49.47 |
| Missouri | 355.13 | Virginia | 0.19 |

The following table, arranged alphabetically by states, gives all totals relative to the granite output for the calendar year 1889. Considering the totals for the United States, it appears that something over 62,000,000 cubic feet of granite, having a total value in round numbers of $14,500,000, were produced by 22,313 workmen from 874 quarries. To this number of men over $9,600,000 in wages was paid. The total expense of producing the entire granite output amounts to over $11,500,000, thus indicating a profit to the producers of about $3,000,000. The total capital invested is over $19,000,000, of which something more than one-half is the value of land.

## PRODUCTION OF GRANITE IN THE UNITED STATES FOR THE CALENDAR YEAR 1889, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | Number of firms producing in 1889. | Number of quarries. | PRODUCT. | | LABOR. | | | | | | | POWER. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cubic feet. | Total value. | Average number of employés. | | | | | | | Number of boilers. | Total horse power of boilers. | Total horse power of water wheels. | Number of animals employed. |
| | | | | | Total number employed. | Foremen. | Quarrymen. | Mechanics and stonecutters. | Laborers. | Boys under 16 years. | Office force. | | | | |
| Total | 814 | 874 | 62, 287, 156 | $14, 464, 095 | 22, 313 | 815 | 10, 006 | 6, 585 | 4, 342 | 343 | 222 | 556 | 15, 119 | 80 | 2, 980 |
| California | 76 | 76 | 4, 761, 411 | 1, 329, 018 | 1, 803 | 64 | 1, 165 | 316 | 225 | 21 | 12 | 41 | 1, 026 | ........ | 139 |
| Colorado | 10 | 10 | 2, 677, 465 | 314, 673 | 213 | 12 | 151 | 13 | 32 | ........ | 5 | 3 | 20 | ........ | 39 |
| Connecticut | 49 | 53 | 3, 835, 704 | 1, 061, 202 | 1, 630 | 43 | 694 | 600 | 251 | 10 | 32 | 47 | 1, 101 | ........ | 202 |
| Delaware | 5 | 5 | 1, 386, 431 | 211, 194 | 253 | 9 | 166 | 67 | 6 | 2 | 3 | 15 | 352 | ........ | 13 |
| Georgia | 24 | 28 | 2, 425, 622 | 752, 481 | 1, 367 | 35 | 442 | 352 | 482 | 51 | 5 | 15 | 777 | ........ | 98 |
| Maine | 133 | 153 | 6, 701, 346 | 2, 225, 839 | 3, 737 | 110 | 1, 453 | 1, 611 | 483 | 53 | 27 | 65 | 1, 723 | 80 | 591 |
| Maryland | 22 | 23 | 3, 371, 032 | 447, 489 | 846 | 26 | 513 | 97 | 171 | 30 | 9 | 24 | 470 | ........ | 202 |
| Massachusetts | 148 | 151 | 9, 587, 996 | 2, 503, 503 | 3, 333 | 136 | 1, 613 | 903 | 613 | 30 | 38 | 123 | 2, 947 | ........ | 484 |
| Minnesota | 19 | 23 | 558, 200 | 356, 782 | 558 | 18 | 223 | 239 | 64 | 10 | 4 | 10 | 253 | ........ | 32 |
| Missouri | 9 | 10 | 1, 264, 317 | 500, 642 | 617 | 16 | 228 | 263 | 79 | 19 | 12 | 19 | 662 | ........ | 79 |
| New Hampshire | 77 | 78 | 2, 822, 026 | 727, 531 | 1, 253 | 83 | 519 | 487 | 148 | 8 | 8 | 37 | 771 | ........ | 286 |
| New Jersey | 20 | 23 | 6, 374, 575 | 425, 673 | 627 | 20 | 214 | 57 | 319 | 12 | 5 | 21 | 1, 060 | ........ | 49 |
| New York | 13 | 13 | 1, 515, 511 | 222, 773 | 401 | 19 | 134 | 108 | 130 | 7 | 3 | ........ | 215 | ........ | 60 |
| North Carolina | 19 | 22 | 708, 267 | 146, 627 | 391 | 13 | 110 | 91 | 149 | 22 | 6 | 9 | 182 | ........ | 46 |
| Oregon | 4 | 4 | 287, 400 | 44, 150 | 54 | 2 | 32 | 9 | 10 | 1 | ........ | ........ | ........ | ........ | 2 |
| Pennsylvania | 62 | 64 | 5, 782, 887 | 623, 252 | 1, 207 | 47 | 562 | 200 | 377 | 11 | 10 | 37 | 1, 246 | ........ | 164 |
| Rhode Island | 35 | 37 | 2, 878, 237 | 931, 216 | 1, 195 | 38 | 313 | 614 | 204 | 12 | 14 | 30 | 879 | ........ | 256 |
| South Carolina | 7 | 9 | 214, 479 | 47, 614 | 99 | 3 | 40 | 28 | 25 | 2 | 1 | 5 | 74 | ........ | 2 |
| South Dakota | 3 | 3 | 786, 120 | 304, 673 | 408 | 13 | 93 | 143 | 153 | 3 | 3 | 3 | 82 | ........ | 26 |
| Texas | 8 | 8 | 20, 400 | 22, 550 | 64 | 3 | 27 | 19 | 13 | 1 | 1 | 3 | 72 | ........ | 10 |
| Utah | 3 | 3 | 123, 500 | 8, 700 | 18 | 2 | 8 | 2 | 4 | 1 | 1 | ........ | ........ | ........ | 1 |
| Vermont | 46 | 53 | 1, 073, 936 | 581, 870 | 961 | 60 | 596 | 155 | 128 | 13 | 9 | 17 | 497 | ........ | 131 |
| Virginia | 13 | 13 | 1, 703, 206 | 332, 548 | 716 | 21 | 333 | 91 | 239 | 24 | 8 | 17 | 370 | ........ | 46 |
| Wisconsin | 5 | 8 | 1, 385, 600 | 266, 095 | 478 | 17 | 345 | 84 | 28 | ........ | 4 | 15 | 340 | ........ | 14 |
| Other states (*a*) | 4 | 4 | 41, 488 | 76, 000 | 84 | 5 | 32 | 36 | 9 | ........ | 2 | ........ | ........ | ........ | 8 |

| STATES AND TERRITORIES. | EXPENSES. | | | | CAPITAL INVESTED. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total expenses incurred in producing entire amount of granite. | Total wages, including salaries paid to office force. | Value of supplies and materials consumed. | All other expenditures for the quarry, such as rent, taxes, interest, insurance, etc. | Total capital. | In land. | In buildings and fixtures. | In tools, live stock, machinery, and supplies on hand. | In cash. |
| Total | $11, 504, 021 | $9, 620, 485 | $1, 446, 485 | $437, 051 | $19, 115, 449 | $10, 897, 417 | $1, 580, 784 | $3, 731, 078 | $2, 906, 170 |
| California | 973, 276 | 809, 205 | 131, 837 | 32, 234 | 2, 829, 794 | 1, 926, 095 | 124, 075 | 402, 348 | 377, 276 |
| Colorado | 214, 180 | 192, 700 | 15, 815 | 5, 665 | 315, 485 | 255. 350 | 20, 550 | 20, 385 | 19, 200 |
| Connecticut | 813, 200 | 697, 080 | 76, 047 | 40, 073 | 891, 889 | 348, 600 | 89, 225 | 262, 945 | 191, 119 |
| Delaware | 191, 662 | 116, 216 | 64, 705 | 10, 741 | 104, 545 | 13, 200 | 4, 255 | 52, 869 | 34, 221 |
| Georgia | 472, 107 | 396, 461 | 56, 807 | 18, 839 | 1, 481, 622 | 1, 267, 474 | 28, 235 | 103, 415 | 82. 498 |
| Maine | 1, 823, 976 | 1, 517, 026 | 252, 071 | 54, 879 | 3, 192, 317 | 1. 377, 735 | 292, 613 | 698, 801 | 823, 168 |
| Maryland | 351, 909 | 275, 566 | 61, 352 | 14, 991 | 640, 448 | 386, 850 | 26, 665 | 77, 379 | 149, 554 |
| Massachusetts | 1, 973, 729 | 1, 630, 128 | 278, 056 | 65, 545 | 2, 235, 759 | 1, 099, 563 | 212, 645 | 567, 703 | 355, 848 |
| Minnesota | 295, 007 | 276, 859 | 14, 509 | 3, 639 | 294, 218 | 142, 627 | 17, 305 | 52, 936 | 81, 350 |
| Missouri | 425, 667 | 349, 208 | 55, 173 | 21, 286 | 593, 100 | 460, 500 | 35, 100 | 64, 000 | 33, 500 |
| New Hampshire | 597, 491 | 529, 945 | 52, 573 | 14, 973 | 761, 362 | 366, 100 | 86, 380 | 164, 850 | 144, 032 |
| New Jersey | 330, 644 | 294, 284 | 32, 513 | 3, 847 | 418, 850 | 115, 700 | 15, 150 | 178, 400 | 109, 600 |
| New York | 217, 160 | 182, 831 | 26, 515 | 7, 814 | 422, 700 | 288, 300 | 50, 000 | 44, 750 | 39, 650 |
| North Carolina | 123, 937 | 101, 134 | 20, 915 | 1, 888 | 255, 130 | 120, 777 | 24, 758 | 102, 265 | 7, 330 |
| Oregon | 37, 033 | 29, 860 | 5, 150 | 2, 023 | 60, 600 | 48, 000 | 500 | 12, 100 | ............. |
| Pennsylvania | 516, 923 | 441, 231 | 56, 135 | 19, 557 | 930, 409 | 525, 178 | 155, 937 | 149, 894 | 99, 400 |
| Rhode Island | 789, 219 | 618, 013 | 113, 572 | 57, 634 | 646, 392 | 279, 770 | 54, 035 | 226, 646 | 85, 941 |
| South Carolina | 35, 028 | 22, 843 | 2, 488 | 9, 697 | 143, 275 | 90. 634 | 7, 775 | 34, 866 | 10, 000 |
| South Dakota | 222, 229 | 216, 773 | 1, 461 | 3, 995 | 444, 566 | 288, 200 | 79, 528 | 66, 838 | 10, 000 |
| Texas | 33, 738 | 20, 464 | 7, 100 | 6, 174 | 212, 125 | 184, 000 | 11. 075 | 15, 350 | 1, 700 |
| Utah | 7, 846 | 7, 696 | 100 | 50 | 18, 750 | 8, 000 | 5, 100 | 2, 650 | 3, 000 |
| Vermont | 477, 114 | 408, 916 | 48, 702 | 19, 496 | 967, 750 | 683, 164 | 63, 741 | 95, 630 | 125, 215 |
| Virginia | 256, 125 | 218, 828 | 32, 297 | 5, 000 | 446, 650 | 234, 900 | 20, 946 | 89, 236 | 101, 568 |
| Wisconsin | 261, 791 | 221, 493 | 30, 292 | 10, 006 | 546, 413 | 144, 700 | 151, 691 | 236, 022 | 14, 000 |
| Other states (*a*) | 63, 030 | 45, 725 | 10, 300 | 7, 005 | 261, 300 | 242, 000 | 3, 500 | 8, 800 | 7, 000 |

*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Arkansas, Montana, Nevada, and Washington.

The table on the following page is presented for the purpose of showing by states, as well as for the entire country, the distribution of granite for the various important purposes to which it is applied. It will be seen that the purposes considered are as follows: building; street work; cemetery, monumental, and decorative purposes; bridge, dam, and railroad work, and miscellaneous uses. This table will be found of particular interest to quarrymen and others who have reason to be interested in statistics relative to the amount and value of stone used for different purposes. In order that the general uses named above may be understood in detail, the following list is presented:

## BUILDING PURPOSES.

Solid fronts.
Foundations.
Cellar walls.
Underpinning.
Steps.
Buttresses.
Window sills.
Lintels.
Broken range.
Sills.
Kiln stone.
Capping.
Columns.
Plinths.
Pilasters.
Belting or belt courses.
Rubble.
Range.
Ashlar.
Forts.
Dimension.

## STREET WORK.

Paving blocks.
Belgian blocks.
Curbing.
Flagging.
Road making—
  (a) Macadam.
  (b) Telford.
  (c) Concrete.
Basin heads or catch-basin corners.
Sledged stone.
Crushed stone.
Breaker dust.

## CEMETERY, MONUMENTAL, AND DECORATIVE PURPOSES.

Statues.
Monuments (entire).
Monument bases.
Monument dies.
Monument shafts.
Gravestone sockets.
Grave markers.
Cemetery posts.
Cemetery rails.
Cemetery coping.
Mausoleums.
Urns.
Wainscoting.
Dados.
Fountains.

## BRIDGE, DAM, AND RAILROAD WORK.

Culverts.
Aqueducts.
Dams.
Wharf stone.
Breakwater.
Jetties.
Piers.
Buttresses.
Bridge covering.
Capstone.
Rails.
Ashlar.
Ballast.
Riprap.
Approaches.
Towers.
Bank stone.
Parapets.
Docks.

## MISCELLANEOUS.

Millstones.
Levelers—rollers.
Grout.
Walls (fences).
Watering troughs.
Posts.
Engine and machine beds.
Random.
Yard stock.
Refuse stone.
Block granite.
Boundary stone.
Horse blocks.

## AMOUNTS AND VALUES OF GRANITE ACCORDING TO THE PURPOSES FOR WHICH IT WAS USED, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | Number of quarries. | BUILDING PURPOSES. | | | STREET WORK. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Cubic feet. | Value. | Value per cubic foot. | Cubic feet, including paving blocks. | Value, including paving blocks. | Value per cubic foot. | Number of paving blocks. | Value of paving blocks. | Value per thousand. |
| Total | 874 | 26,147,338 | $6,166,034 | $0.24 | 20,683,224 | $4,456,891 | $0.22 | 61,822,871 | $2,978,172 | $48.17 |
| California | 76 | 496,352 | 419,816 | 0.85 | 3,284,232 | 551,613 | 0.17 | 7,303,321 | 297,236 | 40.70 |
| Colorado | 10 | 2,620,419 | 294,356 | 0.11 | 1,100 | 230 | 0.21 | ...... | ...... | ...... |
| Connecticut | 53 | 2,358,286 | 758,915 | 0.32 | 567,860 | 109,261 | 0.19 | 761,100 | 40,683 | 53.45 |
| Delaware | 5 | 229,066 | 32,443 | 0.14 | 155,500 | 67,202 | 0.43 | 104,333 | 8,208 | 78.67 |
| Georgia | 28 | 700,939 | 347,100 | 0.50 | 658,603 | 250,634 | 0.38 | 1,599,952 | 84,951 | 53.10 |
| Maine | 153 | 1,819,741 | 839,125 | 0.46 | 3,736,541 | 927,949 | 0.25 | 17,704,915 | 824,113 | 46.55 |
| Maryland | 23 | 1,578,872 | 263,491 | 0.17 | 1,051,010 | 125,958 | 0.12 | 286,950 | 10,310 | 35.93 |
| Massachusetts | 151 | 6,643,703 | 1,362,451 | 0.21 | 1,475,093 | 466,147 | 0.32 | 6,106,016 | 378,627 | 62.01 |
| Minnesota | 23 | 211,548 | 209,396 | 0.99 | 338.640 | 141,554 | 0.42 | 1,239,000 | 68,045 | 54.92 |
| Missouri | 10 | 110,468 | 219,518 | 1.99 | 871,209 | 216,986 | 0.25 | 4,323,130 | 216,986 | 50.19 |
| New Hampshire | 78 | 1,306,331 | 324,567 | 0.25 | 1,157,992 | 252,256 | 0.22 | 2,043,739 | 87,569 | 42.85 |
| New Jersey | 23 | 324,150 | 42,175 | 0.13 | 2,089,796 | 236,310 | 0.11 | 3,999,912 | 168,555 | 42.14 |
| New York | 13 | 1,078,203 | 149,700 | 0.14 | 247,902 | 51,062 | 0.21 | 587,120 | 26,962 | 45.92 |
| North Carolina | 22 | 63,697 | 33,327 | 0.52 | 221,820 | 42,605 | 0.19 | 775,000 | 34,200 | 44.13 |
| Oregon | 4 | 63,000 | 6,300 | 0.10 | 117,400 | 30,200 | 0.26 | 587,000 | 30,200 | 51.45 |
| Pennsylvania | 64 | 2,379,875 | 143,231 | 0.06 | 1,996,486 | 368,323 | 0.18 | 3,836,127 | 241,793 | 63.03 |
| Rhode Island | 37 | 2,349,711 | 266,400 | 0.11 | 213,477 | 65,817 | 0.31 | 781,765 | 45,817 | 58.61 |
| South Carolina | 9 | 25,777 | 8,130 | 0.32 | 94,489 | 34,016 | 0.36 | ...... | ...... | ...... |
| South Dakota | 3 | 185,120 | 133,978 | 0.72 | 601,000 | 170,695 | 0.28 | 3,017,500 | 170,694 | 56.57 |
| Texas | 8 | 19,700 | 21,000 | 1.07 | ...... | ...... | ...... | ...... | ...... | ...... |
| Utah | 3 | 122,900 | 8,310 | 0.07 | ...... | ...... | ...... | ...... | ...... | ...... |
| Vermont | 53 | 236,759 | 45,198 | 0 19 | 231,128 | 48,323 | 0.21 | 883,096 | 45,643 | 51.69 |
| Virginia | 13 | 1,080,873 | 120,467 | 0.11 | 286,946 | 75,925 | 0.26 | 342,895 | 18,505 | 53.97 |
| Wisconsin | 8 | 100,360 | 40,640 | 0.40 | 1,285,000 | 223,825 | 0.17 | 5,540,000 | 179,075 | 32.32 |
| Other states (*a*) | 4 | 41,488 | 76,000 | 1.83 | ...... | ...... | ...... | ...... | ...... | ...... |

| STATES AND TERRITORIES. | Total number of cubic feet. | Total value. | CEMETERY, MONUMENTAL, AND DECORATIVE PURPOSES. | | | BRIDGE, DAM, AND RAILROAD WORK. | | | MISCELLANEOUS USES. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cubic feet. | Value. | Value per cubic foot. | Cubic feet. | Value. | Value per cubic foot. | Cubic feet. | Value. | Value per cubic foot. |
| Total | 62,287,156 | $14,464,095 | 2,106,953 | $2,371,911 | $1.13 | 12,207,244 | $1,238,401 | $0.10 | 1,142,397 | $230,858 | $0.20 |
| California | 4,761,411 | 1,329,018 | 85,927 | 115,114 | 1.34 | 879,900 | 237,475 | 0.27 | 15,000 | 5,000 | 0.33 |
| Colorado | 2,677,465 | 314,673 | 55,946 | 20,087 | 0 36 | ...... | ...... | ...... | ...... | ...... | ...... |
| Connecticut | 3,835,704 | 1,061,202 | 148,108 | 111,155 | 0.75 | 571,031 | 65,659 | 0.11 | 190,419 | 16,212 | 0.09 |
| Delaware | 1,386,431 | 211,194 | ...... | ...... | ...... | 995,982 | 110,849 | 0.11 | 5,883 | 700 | 0.12 |
| Georgia | 2,425,622 | 752,481 | 189,655 | 47,997 | 0.25 | 876,425 | 106,750 | 0.12 | ...... | ...... | ...... |
| Maine | 6,701,346 | 2,225,839 | 231,972 | 299,158 | 1.29 | 856,786 | 145,117 | 0.17 | 56,306 | 14,490 | 0.26 |
| Maryland | 3,371,032 | 447,489 | 31,100 | 19,410 | 0.62 | 710,050 | 38,630 | 0.05 | ...... | ...... | ...... |
| Massachusetts | 9,587,996 | 2,503,503 | 509,087 | 497,438 | 0.98 | 252,288 | 33,040 | 0.13 | 707,825 | 144,427 | 0.20 |
| Minnesota | 558,200 | 356,782 | 5,312 | 4,277 | 0.81 | 2,700 | 1,555 | 0.58 | ...... | ...... | ...... |
| Missouri | 1,264,317 | 500,642 | 120 | 500 | 4.17 | 282,520 | 63,638 | 0.23 | ...... | ...... | ...... |
| New Hampshire | 2,822,026 | 727,531 | 151,711 | 135,029 | 0.89 | 110,467 | 8,409 | 0.08 | 95,525 | 7,270 | 0.08 |
| New Jersey | 6,374,575 | 425,673 | 250 | 125 | 0.50 | 3,960,379 | 147,063 | 0.04 | ...... | ...... | ...... |
| New York | 1,515,511 | 222,773 | 121,906 | 17,261 | 0.14 | 67,500 | 4,750 | 0.07 | ...... | ...... | ...... |
| North Carolina | 708,267 | 146,627 | 25,106 | 23,345 | 0.93 | 378,500 | 44,240 | 0.12 | 19,144 | 3,110 | 0.16 |
| Oregon | 287,400 | 44,150 | 2,000 | 2,350 | 1.18 | 105,000 | 5,300 | 0.05 | ...... | ...... | ...... |
| Pennsylvania | 5,782,887 | 623,252 | 15,050 | 5,725 | 0.38 | 1,383,976 | 101,473 | 0.07 | 7,500 | 4,500 | 0.60 |
| Rhode Island | 2,878,237 | 931,216 | 110,310 | 588,199 | 5.33 | 204,739 | 10,800 | 0.05 | ...... | ...... | ...... |
| South Carolina | 214,479 | 47,614 | 4,213 | 2,528 | 0.60 | 90,000 | 2,940 | 0.03 | ...... | ...... | ...... |
| South Dakota | 786,120 | 304,673 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Texas | 20,400 | 22,550 | 700 | 1,550 | 2.21 | ...... | ...... | ...... | ...... | ...... | ...... |
| Utah | 123,500 | 8,700 | 600 | 390 | 0.65 | ...... | ...... | ...... | ...... | ...... | ...... |
| Vermont | 1,073,936 | 581.870 | 373,020 | 412,287 | 1.11 | 197,834 | 41,713 | 0.21 | 35,195 | 34,349 | 0.98 |
| Virginia | 1,703,206 | 332,548 | 44,620 | 66,356 | 1.49 | 281,167 | 69,000 | 0.25 | 9,600 | 800 | 0.08 |
| Wisconsin | 1,385,600 | 266,095 | 240 | 1,630 | 6.79 | ...... | ...... | ...... | ...... | ...... | ...... |
| Other states (*a*) | 41,488 | 76,000 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |

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[a] The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Arkansas, Montana, Nevada, and Washington.

Owing to the fact that operations have been under way for only a short period of time, a number of the states named in the table have produced but limited amounts of stone. These states are as follows: Arkansas, Montana, Nevada, South Carolina, Oregon, Texas, Utah, and Washington. Figures representing the value per unit of the product from such states as these can not be regarded as strictly normal; that is to say, the values are in general decidedly higher than those for states in which production has been going on actively for a number of years. The industry being new in these states, and transportation charges high on stone from a distance, it is of course to be expected that a higher price can be obtained than in other states in which competition on stone locally produced is active. The most valuable of the figures representing values per unit are those for states in which the quarrying industry has long been established, such as Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, Vermont, Virginia, and Wisconsin. Considerable variation in the values per unit for these states is evident, and this is due to differences in the quality of the stone and its degree of finish and the transportation charges to which a competing material from a distance would be subjected.

Considering the subject of paving blocks, the value per thousand is found to vary from $32.32 in Wisconsin to $78.67 in Delaware. In the most important states which produce paving blocks, namely, California, Maine, Massachusetts, Missouri, New Jersey, and Pennsylvania, the value varies from $40 to something over $60 per thousand. The variation in the price for these states, in all of which the production of paving blocks has been going on for some time, is due to the quality of the stone used for these purposes, and also to the special care observed in trimming blocks to certain definite sizes. In some localities surface rock of inferior quality is broken up into paving blocks, which are sold at low prices. In a number of cities considerable care is taken by municipal authorities in the selection of paving material. This care is exercised both with reference to the quality of stone and to invariability of size, and consequently the price paid is in some cases markedly higher than that paid in other cities more indifferent in regard to the material employed.

Considering cemetery purposes, a very wide variation in price exists, ranging all the way from 14 cents a cubic foot in New York, where comparatively little of such work is done, to $6.79 in Wisconsin, where also very little, indeed, was done, amounting perhaps to only 2 or 3 contracts; so that the reasons for these extremes in prices are at once apparent. In Rhode Island the average price reaches the high figure of $5.33 per cubic foot, which results from the fact that most of the stone used for these purposes in Rhode Island, coming from Westerly, is unusually well adapted for such work; further, the ornamentation and finish put upon the Westerly granite is of a very high order.

The value per unit of the product used for bridge, dam, and railroad work is naturally low, although it shows considerable variation.

Comparing the grand totals for the various purposes, it appears that of the entire output of the country $6,000,000 worth, or something less than half, is devoted to building purposes, and a little less than one-third to street work, of which more than half is the value of paving blocks. The value of the stone devoted to cemetery, monumental, and decorative purposes is about one-sixth of the entire amount, but its value per cubic foot, namely, $1.13, is naturally vastly in excess of the value per unit of the stone used for any other purpose. Something less than one-tenth of the value of the output is devoted to bridge, dam, and railroad work, while the value for miscellaneous uses is quite small.

Comparing the various states, it appears that for building purposes the value of the product in Massachusetts is decidedly in advance of that for any other state, Maine standing second, Connecticut third, and California fourth. In street work Maine is largely in the lead, California taking second place, while Massachusetts, which for total production heads the whole list, stands third. In connection with cemetery and monumental work, it is interesting to notice that Rhode Island stands at the head of the list, the value of its output amounting to nearly $600,000, Massachusetts coming second, and Vermont third. In Massachusetts and Vermont, respectively, the leading localities producing fine ornamental work are Quincy, in Massachusetts, and Barre, in Vermont. In the latter locality production, although carried on to a limited extent in 1880, has largely developed within the past 10 years. In value of granite devoted to bridge, dam, and railroad work California stands first, New Jersey second, Maine third, Delaware fourth, and Georgia fifth.

## LABOR.

The table on page 608 includes figures relative to the average wages received and the average number of days employed by the various classes of workmen connected with granite quarrying. Considering the daily wages paid to foremen, it is noticeable that among those states in which the granite industry has long been prosecuted the average is fairly constant, varying from $3 in Virginia to $3.41 in New Hampshire. In the western states the average is markedly higher, being $4.34 in California, $3.67 in Minnesota, and $4.34 in Wisconsin. The foremen employed in western states naturally come, in great part, from the old-established quarry regions of the east, and their services therefore command a higher figure in these comparatively undeveloped regions. This statement, together with the fact of increased cost of living, accounts for the higher wages paid in these states. Very much the same condition is found to exist with the other classes of labor, quarrymen, for example, in California receiving $2.38, in Colorado $2.50, and in Utah $3. In the older granite-producing states wages for quarrymen amount to about $1.75 per day, but in the southern states the amount is invariably less. In connection with mechanics, it will be noticed that the number in Maine is almost twice as great as that in Massachusetts. This great difference has been found to be due to the respective methods of classification of mechanics in these 2 states. In Maine it is a common practice to include stonecutters among mechanics, whereas in Massachusetts engineers, blacksmiths, and the like make up the number of mechanics. It is interesting to note in this connection that the average value per cubic foot of the total output in Maine is 33 cents, while for Massachusetts it is 26 cents; in other words, a greater output of finished product in Maine than in Massachusetts is indicated, and therefore this serves to explain the greater number of mechanics in the former than in the latter state. Wages for laborers in most of the states is not far from $1.50 per day, although low figures are noticeable for the southern states. The highest figures paid are in the western states, as, for example, $2.11 in California and $1.96 in Colorado. In regard to the number of boys under 16 years of age employed in connection with the granite industry, it is noted that Maine employs nearly twice as many as Massachusetts. The total number, however, for the whole United States is only 343. As an explanation of this, it may be stated that in Maine there are a great many small quarries operated by farmers. After the farm work is practically done for the year attention is devoted to the development of such quarry property as may be included in these farms. Maine and Georgia together employ 104 boys, or nearly one-third of the total number employed in the United States. The wages paid to boys vary considerably, being less than $1 per day, although in a few cases this amount is exceeded.

It will be noticed that the total wages reported in the table on page 608 as actually paid do not exactly agree with the figures which would result from computing the total wages from the data given in the table on page 611. This is very naturally the case, since the figures of the latter table are the averages given by the producers in response to an inquiry calling for average statements. The figures for total wages actually paid are exact.

The table on page 609 gives the relative standing of the various states according to the value of output and the purposes for which the product was used.

The table on page 610 shows the relative standing according to the number of cubic feet and purposes. It will be observed that the relative standing is quite variable, according to the various uses.

The table on page 611 gives the states in the order of their relative importance with respect to a number of different statistical items. It will be noticed that this order varies considerably. Thus, while Massachusetts and Maine hold first and second places, respectively, both with reference to the value of output as well as the number of cubic feet, New Jersey is third when the number of cubic feet is considered, whereas its position with respect to value of output is twelfth. Inspection of this table will reveal at a glance a number of interesting features which would require some time and labor to extract from the principal table relative to production, in which all these items are contained. The most important of these items in determining the true relative standing of the states is, of course, the value of the output, but for persons specially interested in granite the other items will undoubtedly be found of interest and value. Considering the capital invested in land, Massachusetts and Maine, instead of holding first and second places, respectively, drop to fourth and second places, while California heads the list. Exceedingly high values have been placed on some quarry property, for the reason that the area included was very large, while the value per acre may not have been excessive. It is true that in many places in the west large areas of land have been bought up for the sake of controlling the production of the granite contained in it, and while but a small portion of this area may have been actually worked for granite, still, as land was purchased as quarry property, the purchasers are justified in representing as invested in quarry land all that was paid for the tract, even though it was very large. The reason for such large purchases of land in undeveloped portions of the country is evidently to cut off possible competition by monopolizing the best territory. Thus, Texas, which stood in twenty-third place with regard to value of output in 1889, holds sixteenth place according to the capital invested in land.

## LABOR AND WAGES CLASSIFIED, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | FOREMEN. | | | | QUARRYMEN. | | | | MECHANICS. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number. | Average daily wages. | Average number of days. | Average yearly earnings. | Average number. | Average daily wages. | Average number of days. | Average yearly earnings. | Average number. | Average daily wages. | Average number of days. | Average yearly earnings. |
| California | 64 | $4.34 | 214 | $928.76 | 1,165 | $2.38 | 217 | $516.46 | 316 | $3.52 | 215 | $756.80 |
| Colorado | 12 | 3.42 | 202 | 690.84 | 151 | 2.50 | 214 | 535.00 | 13 | 2.98 | 239 | 712.22 |
| Connecticut | 43 | 3.15 | 243 | 765.45 | 694 | 1.70 | 230 | 391.00 | 600 | 2.67 | 247 | 659.49 |
| Delaware | 9 | 3.27 | 242 | 791.34 | 166 | 1.66 | 229 | 380.14 | 67 | 2.82 | 232 | 654.24 |
| Georgia | 35 | 3.72 | 268 | 996.96 | 442 | 1.36 | 222 | 301.92 | 352 | 3.59 | 218 | 782.62 |
| Maine | 110 | 3.15 | 215 | 677.25 | 1,453 | 1.78 | 177 | 315.06 | 1,611 | 2.49 | 220 | 547.80 |
| Maryland | 26 | 3.00 | 232 | 696.00 | 513 | 1.51 | 244 | 368.44 | 97 | 3.02 | 247 | 745.94 |
| Massachusetts | 136 | 3.09 | 248 | 766.32 | 1,613 | 1.76 | 221 | 388.96 | 903 | 2.59 | 247 | 639.73 |
| Minnesota | 18 | 3.67 | 204 | 748.68 | 223 | 1.84 | 196 | 360.64 | 239 | 3.54 | 206 | 729.24 |
| Missouri | 16 | 3.19 | 220 | 701.80 | 228 | 1.74 | 219 | 381.06 | 263 | 3.15 | 199 | 626.85 |
| New Hampshire | 83 | 3.41 | 170 | 579.70 | 519 | 1.75 | 178 | 311.50 | 487 | 2.60 | 223 | 579.80 |
| New Jersey | 20 | 2.47 | 250 | 617.50 | 214 | 1.65 | 231 | 381.15 | 57 | 2.19 | 238 | 521.22 |
| New York | 19 | 2.91 | 245 | 712.95 | 134 | 1.87 | 200 | 374.00 | 108 | 2.92 | 178 | 519.76 |
| North Carolina | 13 | 2.52 | 241 | 607.32 | 110 | 1.12 | 208 | 232.96 | 91 | 1.82 | 197 | 358.54 |
| Oregon | 2 | 5.00 | 200 | 1,000.00 | 32 | 2.50 | 213 | 532.50 | 2 | 3.00 | 211 | 633.00 |
| Pennsylvania | 47 | 2.36 | 189 | 446.04 | 562 | 1.75 | 187 | 327.25 | 200 | 2.64 | 200 | 528.00 |
| Rhode Island | 38 | 3.35 | 255 | 854.25 | 313 | 1.84 | 212 | 390.08 | 614 | 2.46 | 257 | 632.22 |
| South Carolina | 3 | 5.75 | 222 | 1,276.50 | 40 | 0.95 | 181 | 171.95 | 28 | 2.98 | 213 | 634.74 |
| South Dakota | 13 | 3.50 | 313 | 1,095.50 | 93 | 2.00 | 200 | 400.00 | 143 | 4.00 | 200 | 800.00 |
| Texas | 3 | 2.50 | 200 | 500.00 | 27 | 1.57 | 110 | 172.70 | 19 | 3.82 | 127 | 485.14 |
| Utah | 2 | 3.50 | 178 | 623.00 | 8 | 3.00 | 175 | 525.00 | 2 | 3.50 | 178 | 623.00 |
| Vermont | 60 | 3.68 | 202 | 743.36 | 596 | 1.75 | 186 | 325.50 | 155 | 2.64 | 216 | 570.24 |
| Virginia | 21 | 3.00 | 240 | 720.00 | 333 | 1.22 | 189 | 230.58 | 91 | 2.61 | 222 | 579.42 |
| Wisconsin | 17 | 4.34 | 301 | 1,306.34 | 345 | 1.70 | 274 | 465.80 | 84 | 3.09 | 216 | 667.44 |
| Other states (*a*) | 5 | 5.77 | 188 | 1,084.76 | 32 | 2.66 | 162 | 430.92 | 36 | 4.75 | 151 | 717.25 |

| STATES AND TERRITORIES. | LABORERS. | | | | BOYS UNDER 16 YEARS. | | | | OFFICE FORCE. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Average number. | Average daily wages. | Average number of days. | Average yearly earnings. | Average number. | Average daily wages. | Average number of days. | Average yearly earnings. | Average number. | Average annual salary. |
| California | 225 | $2.11 | 194 | $409.34 | 21 | $1.05 | 230 | $241.50 | 12 | $1,111.11 |
| Colorado | 32 | 1.96 | 228 | 446.88 | ........ | ........ | ........ | ........ | 5 | 966.67 |
| Connecticut | 251 | 1.48 | 232 | 343.36 | 10 | 0.86 | 147 | 126.42 | 32 | 761.22 |
| Delaware | 6 | 1.50 | 240 | 360.00 | 2 | 0.50 | 230 | 115.00 | 3 | 1,266.67 |
| Georgia | 482 | 1.05 | 231 | 242.55 | 51 | 0.62 | 224 | 138.88 | 5 | 933.33 |
| Maine | 483 | 1.62 | 187 | 302.94 | 53 | 0.92 | 149 | 137.08 | 27 | 938.75 |
| Maryland | 171 | 1.34 | 196 | 262.64 | 30 | 0.65 | 221 | 143.65 | 9 | 677.78 |
| Massachusetts | 613 | 1.50 | 240 | 360.00 | 30 | 0.71 | 224 | 159.04 | 38 | 911.21 |
| Minnesota | 64 | 1.57 | 200 | 314.00 | 10 | 1.07 | 198 | 211.86 | 4 | 900.00 |
| Missouri | 79 | 1.48 | 185 | 273.80 | 19 | 0.65 | 229 | 148.85 | 12 | 808.98 |
| New Hampshire | 148 | 1.68 | 163 | 273.84 | 8 | 1.20 | 166 | 199.20 | 8 | 755.00 |
| New Jersey | 319 | 1.43 | 224 | 320.32 | 12 | 0.75 | 300 | 225.00 | 5 | 500.00 |
| New York | 130 | 1.71 | 258 | 441.18 | 7 | 0.79 | 185 | 146.15 | 3 | 970.00 |
| North Carolina | 149 | 0.84 | 202 | 169.68 | 22 | 0.35 | 192 | 67.20 | 6 | 680.00 |
| Oregon | 10 | 2.00 | 220 | 440.00 | 1 | 1.00 | 150 | 150.00 | ........ | ........ |
| Pennsylvania | 377 | 1.37 | 182 | 249.34 | 11 | 0.73 | 210 | 153.30 | 10 | 603.75 |
| Rhode Island | 204 | 1.54 | 227 | 349.58 | 12 | 0.69 | 218 | 150.42 | 14 | 1,047.38 |
| South Carolina | 25 | 0.78 | 28 | 21.84 | 2 | 0.25 | 265 | 66.25 | 1 | 345.00 |
| South Dakota | 153 | 1.50 | 200 | 300.00 | 3 | 1.00 | 235 | 235.00 | 3 | 1,266.67 |
| Texas | 13 | 1.17 | 224 | 262.08 | 1 | 1.00 | 150 | 150.00 | 1 | ........ |
| Utah | 4 | 2.00 | 125 | 250.00 | 1 | 1.00 | 200 | 200.00 | 1 | 200.00 |
| Vermont | 128 | 1.45 | 170 | 246.50 | 13 | 1.00 | 169 | 169.00 | 9 | 854.33 |
| Virginia | 239 | 1.08 | 216 | 233.28 | 24 | 0.47 | 184 | 86.48 | 8 | 881.43 |
| Wisconsin | 28 | 1.37 | 156 | 213.72 | ........ | ........ | ........ | ........ | 4 | 630.00 |
| Other states (*a*) | 9 | 1.81 | 89 | 161.09 | ........ | ........ | ........ | ........ | 2 | 500.00 |

*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Arkansas, Montana, Nevada, and Washington.

## RELATIVE STANDING OF STATES ACCORDING TO VALUE AND PURPOSES.

### BUILDING PURPOSES.

| States and territories. | Value. |
|---|---|
| Total | $6,166,034 |
| 1 Massachusetts | 1,362,451 |
| 2 Maine | 839,125 |
| 3 Connecticut | 758,915 |
| 4 California | 419,816 |
| 5 Georgia | 347,100 |
| 6 New Hampshire | 324,567 |
| 7 Colorado | 294,356 |
| 8 Rhode Island | 266,400 |
| 9 Maryland | 263,491 |
| 10 Missouri | 219,518 |
| 11 Minnesota | 209,396 |
| 12 New York | 149,700 |
| 13 Pennsylvania | 143,231 |
| 14 South Dakota | 133,978 |
| 15 Virginia | 120,467 |
| 16 Vermont | 45,198 |
| 17 New Jersey | 42,175 |
| 18 Wisconsin | 40,640 |
| 19 North Carolina | 33,327 |
| 20 Delaware | 32,443 |
| 21 Texas | 21,000 |
| 22 Utah | 8,310 |
| 23 South Carolina | 8,130 |
| 24 Oregon | 6,300 |
| Other states (*a*) | 76,000 |

### STREET WORK (INCLUDING PAVING BLOCKS).

| States and territories. | Value. |
|---|---|
| Total | $4,456,891 |
| Maine | 927,949 |
| California | 551,613 |
| Massachusetts | 466,147 |
| Pennsylvania | 368,323 |
| New Hampshire | 252,256 |
| Georgia | 250,634 |
| New Jersey | 236,310 |
| Wisconsin | 223,825 |
| Missouri | 216,986 |
| South Dakota | 170,695 |
| Minnesota | 141,554 |
| Maryland | 125,958 |
| Connecticut | 109,261 |
| Virginia | 75,925 |
| Delaware | 67,202 |
| Rhode Island | 65,817 |
| New York | 51,062 |
| Vermont | 48,323 |
| North Carolina | 42,605 |
| South Carolina | 34,016 |
| Oregon | 30,200 |
| Colorado | 230 |

### PAVING BLOCKS.

| States and territories. | Value. |
|---|---|
| Total | $2,978,172 |
| Maine | 824,113 |
| Massachusetts | 378,627 |
| California | 297,236 |
| Pennsylvania | 241,793 |
| Missouri | 216,986 |
| Wisconsin | 179,075 |
| South Dakota | 170,694 |
| New Jersey | 168,555 |
| New Hampshire | 87,569 |
| Georgia | 84,951 |
| Minnesota | 68,045 |
| Rhode Island | 45,817 |
| Vermont | 45,643 |
| Connecticut | 40,683 |
| North Carolina | 34,200 |
| Oregon | 30,200 |
| New York | 26,962 |
| Virginia | 18,505 |
| Maryland | 10,310 |
| Delaware | 8,208 |

### CEMETERY, MONUMENTAL, AND DECORATIVE PURPOSES.

| States and territories. | Value. |
|---|---|
| Total | $2,371,911 |
| 1 Rhode Island | 588,199 |
| 2 Massachusetts | 497,438 |
| 3 Vermont | 412,287 |
| 4 Maine | 299,158 |
| 5 New Hampshire | 135,029 |
| 6 California | 115,114 |
| 7 Connecticut | 111,155 |
| 8 Virginia | 66,356 |
| 9 Georgia | 47,997 |
| 10 North Carolina | 23,345 |
| 11 Colorado | 20,087 |
| 12 Maryland | 19,410 |
| 13 New York | 17,261 |
| 14 Pennsylvania | 5,725 |
| 15 Minnesota | 4,277 |
| 16 South Carolina | 2,528 |
| 17 Oregon | 2,350 |
| 18 Wisconsin | 1,630 |
| 19 Texas | 1,550 |
| 20 Missouri | 500 |
| 21 Utah | 390 |
| 22 New Jersey | 125 |

### BRIDGE, DAM, AND RAILROAD WORK.

| States and territories. | Value. |
|---|---|
| Total | $1,238,401 |
| California | 237,475 |
| New Jersey | 147,063 |
| Maine | 145,117 |
| Delaware | 110,849 |
| Georgia | 106,750 |
| Pennsylvania | 101,473 |
| Virginia | 69,000 |
| Connecticut | 65,659 |
| Missouri | 63,638 |
| North Carolina | 44,240 |
| Vermont | 41,713 |
| Maryland | 38,630 |
| Massachusetts | 33,040 |
| Rhode Island | 10,800 |
| New Hampshire | 8,409 |
| Oregon | 5,300 |
| New York | 4,750 |
| South Carolina | 2,940 |
| Minnesota | 1,555 |

### MISCELLANEOUS USES.

| States and territories. | Value. |
|---|---|
| Total | $230,858 |
| Massachusetts | 144,427 |
| Vermont | 34,349 |
| Connecticut | 16,212 |
| Maine | 14,490 |
| New Hampshire | 7,270 |
| California | 5,000 |
| Pennsylvania | 4,500 |
| North Carolina | 3,110 |
| Virginia | 800 |
| Delaware | 700 |

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[a] The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Arkansas, Montana, Nevada, and Washington.

## RELATIVE STANDING OF STATES ACCORDING TO NUMBER OF CUBIC FEET AND PURPOSES.

### BUILDING PURPOSES.

| States and territories. | Cubic feet. |
|---|---|
| Total | 26,147,338 |
| 1 Massachusetts | 6,643,703 |
| 2 Colorado | 2,620,419 |
| 3 Pennsylvania | 2,379,875 |
| 4 Connecticut | 2,358,286 |
| 5 Rhode Island | 2,349,711 |
| 6 Maine | 1,819,741 |
| 7 Maryland | 1,578,872 |
| 8 New Hampshire | 1,306,331 |
| 9 Virginia | 1,080,873 |
| 10 New York | 1,078,203 |
| 11 Georgia | 700,939 |
| 12 California | 496,352 |
| 13 New Jersey | 324,150 |
| 14 Vermont | 236,759 |
| 15 Delaware | 229,066 |
| 16 Minnesota | 211,548 |
| 17 South Dakota | 185,120 |
| 18 Utah | 122,900 |
| 19 Missouri | 110,468 |
| 20 Wisconsin | 100,360 |
| 21 North Carolina | 63,697 |
| 22 Oregon | 63,000 |
| 23 South Carolina | 25,777 |
| 24 Texas | 19,700 |
| Other states (*a*) | 41,488 |

### ALL CLASSES OF STREET WORK.

| States and territories. | Cubic feet. |
|---|---|
| Total | 20,683,224 |
| Maine | 3,736,541 |
| California | 3,284,232 |
| New Jersey | 2,089,796 |
| Pennsylvania | 1,996,486 |
| Massachusetts | 1,475,093 |
| Wisconsin | 1,285,000 |
| New Hampshire | 1,157,992 |
| Maryland | 1,051,010 |
| Missouri | 871,209 |
| Georgia | 658,603 |
| South Dakota | 601,000 |
| Connecticut | 567,860 |
| Minnesota | 338,640 |
| Virginia | 286,946 |
| New York | 247,902 |
| Vermont | 231,128 |
| North Carolina | 221,820 |
| Rhode Island | 213,477 |
| Delaware | 155,500 |
| Oregon | 117,400 |
| South Carolina | 94,489 |
| Colorado | 1,100 |

### PAVING BLOCKS.

| States and territories. | Number. |
|---|---|
| Total | 61,822,871 |
| Maine | 17,704,915 |
| California | 7,303,321 |
| Massachusetts | 6,106,016 |
| Wisconsin | 5,540,000 |
| Missouri | 4,323,130 |
| New Jersey | 3,999,912 |
| Pennsylvania | 3,836,127 |
| South Dakota | 3,017,500 |
| New Hampshire | 2,043,739 |
| Georgia | 1,599,952 |
| Minnesota | 1,239,000 |
| Vermont | 883,096 |
| Rhode Island | 781,765 |
| North Carolina | 775,000 |
| Connecticut | 761,100 |
| New York | 587,120 |
| Oregon | 587,000 |
| Virginia | 342,895 |
| Maryland | 286,950 |
| Delaware | 104,333 |

### CEMETERY, MONUMENTAL, AND DECORATIVE PURPOSES.

| States and territories. | Cubic feet. |
|---|---|
| Total | 2,106,953 |
| 1 Massachusetts | 509,087 |
| 2 Vermont | 373,020 |
| 3 Maine | 231,972 |
| 4 Georgia | 189,655 |
| 5 New Hampshire | 151,711 |
| 6 Connecticut | 148,108 |
| 7 New York | 121,906 |
| 8 Rhode Island | 110,310 |
| 9 California | 85,927 |
| 10 Colorado | 55,946 |
| 11 Virginia | 44,620 |
| 12 Maryland | 31,100 |
| 13 North Carolina | 25,106 |
| 14 Pennsylvania | 15,050 |
| 15 Minnesota | 5,312 |
| 16 South Carolina | 4,213 |
| 17 Oregon | 2,000 |
| 18 Texas | 700 |
| 19 Utah | 600 |
| 20 New Jersey | 250 |
| 21 Wisconsin | 240 |
| 22 Missouri | 120 |

### BRIDGE, DAM, AND RAILROAD WORK.

| States and territories. | Cubic feet. |
|---|---|
| Total | 12,207,244 |
| New Jersey | 3,960,379 |
| Pennsylvania | 1,383,976 |
| Delaware | 995,982 |
| California | 879,900 |
| Georgia | 876,425 |
| Maine | 856,786 |
| Maryland | 710,050 |
| Connecticut | 571,031 |
| North Carolina | 378,500 |
| Missouri | 282,520 |
| Virginia | 281,167 |
| Massachusetts | 252,288 |
| Rhode Island | 204,739 |
| Vermont | 197,834 |
| New Hampshire | 110,467 |
| Oregon | 105,000 |
| South Carolina | 90,000 |
| New York | 67,500 |
| Minnesota | 2,700 |

### MISCELLANEOUS USES.

| States and territories. | Cubic feet. |
|---|---|
| Total | 1,142,397 |
| Massachusetts | 707,825 |
| Connecticut | 190,419 |
| New Hampshire | 95,525 |
| Maine | 56,306 |
| Vermont | 35,195 |
| North Carolina | 19,144 |
| California | 15,000 |
| Virginia | 9,600 |
| Pennsylvania | 7,500 |
| Delaware | 5,883 |

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*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Arkansas, Montana, Nevada, and Washington.

### RELATIVE STANDING OF STATES ACCORDING TO VARIOUS STATISTICAL ITEMS.

| TOTAL NUMBER OF CUBIC FEET PRODUCED. | | TOTAL VALUE OF PRODUCTION. | | TOTAL CAPITAL INVESTED IN LAND. | | TOTAL CAPITAL. | |
|---|---|---|---|---|---|---|---|
| States and territories. | Cubic feet. | States and territories. | Value. | States and territories. | Amount. | States and territories. | Amount. |
| Total | 62,287,156 | Total | $14,464,095 | Total | $10,897,417 | Total | $19,115,449 |
| 1 Massachusetts | 9,587,996 | Massachusetts | 2,503,503 | California | 1,926,095 | Maine | 3,192,317 |
| 2 Maine | 6,701,346 | Maine | 2,225,839 | Maine | 1,377,735 | California | 2,829,794 |
| 3 New Jersey | 6,374,575 | California | 1,329,018 | Georgia | 1,267,474 | Massachusetts | 2,235,759 |
| 4 Pennsylvania | 5,782,887 | Connecticut | 1,061,202 | Massachusetts | 1,099,563 | Georgia | 1,481,622 |
| 5 California | 4,761,411 | Rhode Island | 931,216 | Vermont | 683,164 | Vermont | 967,750 |
| 6 Connecticut | 3,835,704 | Georgia | 752,481 | Pennsylvania | 525,178 | Pennsylvania | 930,409 |
| 7 Maryland | 3,371,032 | New Hampshire | 727,531 | Missouri | 460,500 | Connecticut | 891,889 |
| 8 Rhode Island | 2,878,237 | Pennsylvania | 623,252 | Maryland | 386,850 | New Hampshire | 761,362 |
| 9 New Hampshire | 2,822,026 | Vermont | 581,870 | New Hampshire | 366,100 | Rhode Island | 646,392 |
| 10 Colorado | 2,677,465 | Missouri | 500,642 | Connecticut | 348,600 | Maryland | 640,448 |
| 11 Georgia | 2,425,622 | Maryland | 447,489 | New York | 288,300 | Missouri | 593,100 |
| 12 Virginia | 1,703,206 | New Jersey | 425,673 | South Dakota | 288,200 | Wisconsin | 546,413 |
| 13 New York | 1,515,511 | Minnesota | 356,782 | Rhode Island | 279,770 | Virginia | 446,650 |
| 14 Delaware | 1,386,431 | Virginia | 332,548 | Colorado | 255,350 | South Dakota | 444,566 |
| 15 Wisconsin | 1,385,600 | Colorado | 314,673 | Virginia | 234,900 | New York | 422,700 |
| 16 Missouri | 1,264,317 | South Dakota | 304,673 | Texas | 184,000 | New Jersey | 418,850 |
| 17 Vermont | 1,073,936 | Wisconsin | 266,095 | Wisconsin | 144,700 | Colorado | 315,485 |
| 18 South Dakota | 786,120 | New York | 222,773 | Minnesota | 142,627 | Minnesota | 294,218 |
| 19 North Carolina | 708,267 | Delaware | 211,194 | North Carolina | 120,777 | North Carolina | 255,130 |
| 20 Minnesota | 558,200 | North Carolina | 146,627 | New Jersey | 115,700 | Texas | 212,125 |
| 21 Oregon | 287,400 | South Carolina | 47,614 | South Carolina | 90,634 | South Carolina | 143,275 |
| 22 South Carolina | 214,479 | Oregon | 44,150 | Oregon | 48,000 | Delaware | 104,545 |
| 23 Utah | 123,500 | Texas | 22,550 | Delaware | 13,200 | Oregon | 60,600 |
| 24 Texas | 20,400 | Utah | 8,700 | Utah | 8,000 | Utah | 18,750 |
| Other states (*a*) | 41,488 | Other states | 76,000 | Other states | 242,000 | Other states | 261,300 |

| TOTAL NUMBER OF EMPLOYÉS. | | TOTAL AMOUNT OF WAGES PAID EMPLOYÉS. | | TOTAL COST OF SUPPLIES. | | TOTAL EXPENSE. | |
|---|---|---|---|---|---|---|---|
| States and territories. | Number. | States and territories. | Amount. | States and territories. | Amount. | States and territories. | Amount. |
| Total | 22,313 | Total | $9,620,485 | Total | $1,446,485 | Total | $11,504,021 |
| 1 Maine | 3,737 | Massachusetts | 1,630,128 | Massachusetts | 278,056 | Massachusetts | 1,973,729 |
| 2 Massachusetts | 3,333 | Maine | 1,517,026 | Maine | 252,071 | Maine | 1,823,976 |
| 3 California | 1,803 | California | 809,205 | California | 131,837 | California | 973,276 |
| 4 Connecticut | 1,630 | Connecticut | 697,080 | Rhode Island | 113,572 | Connecticut | 813,200 |
| 5 Georgia | 1,367 | Rhode Island | 618,013 | Connecticut | 76,047 | Rhode Island | 789,219 |
| 6 New Hampshire | 1,253 | New Hampshire | 529,945 | Delaware | 64,705 | New Hampshire | 597,491 |
| 7 Pennsylvania | 1,207 | Pennsylvania | 441,231 | Maryland | 61,352 | Pennsylvania | 516,923 |
| 8 Rhode Island | 1,195 | Vermont | 408,916 | Georgia | 56,807 | Vermont | 477,114 |
| 9 Vermont | 961 | Georgia | 396,461 | Pennsylvania | 56,135 | Georgia | 472,107 |
| 10 Maryland | 846 | Missouri | 349,208 | Missouri | 55,173 | Missouri | 425,667 |
| 11 Virginia | 716 | New Jersey | 294,284 | New Hampshire | 52,573 | Maryland | 351,909 |
| 12 New Jersey | 627 | Minnesota | 276,859 | Vermont | 48,702 | New Jersey | 330,644 |
| 13 Missouri | 617 | Maryland | 275,566 | New Jersey | 32,513 | Minnesota | 295,007 |
| 14 Minnesota | 558 | Wisconsin | 221,493 | Virginia | 32,297 | Wisconsin | 261,791 |
| 15 Wisconsin | 478 | Virginia | 218,828 | Wisconsin | 30,292 | Virginia | 256,125 |
| 16 South Dakota | 408 | South Dakota | 216,773 | New York | 26,515 | South Dakota | 222,229 |
| 17 New York | 401 | Colorado | 192,700 | North Carolina | 20,915 | New York | 217,160 |
| 18 North Carolina | 391 | New York | 182,831 | Colorado | 15,815 | Colorado | 214,180 |
| 19 Delaware | 253 | Delaware | 116,216 | Minnesota | 14,509 | Delaware | 191,662 |
| 20 Colorado | 213 | North Carolina | 101,134 | Texas | 7,100 | North Carolina | 123,937 |
| 21 South Carolina | 99 | Oregon | 29,860 | Oregon | 5,150 | Oregon | 37,033 |
| 22 Texas | 64 | South Carolina | 22,843 | South Carolina | 2,488 | South Carolina | 35,028 |
| 23 Oregon | 54 | Texas | 20,464 | South Dakota | 1,461 | Texas | 33,738 |
| 24 Utah | 18 | Utah | 7,696 | Utah | 100 | Utah | 7,846 |
| Other states (*a*) | 84 | Other states | 45,725 | Other states | 10,300 | Other states | 63,030 |

*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Arkansas, Montana, Nevada, and Washington.

The following table gives a number of deductions from the figures of the table on production, such as the percentages of profit on capital, and also on sales in the different states. It will be noticed that in a few instances loss is reported, but in all these cases the operations have been quite limited and only recently begun. Initial operations in the quarrying industry are invariably attended by loss for some time after making the first opening, due to the considerable amount of stripping which is inevitable in almost every case. To this statement there are occasional exceptions, among which may be specially noted the granite obtained from Stone mountain, in Georgia, where no stripping is necessary, and even the surface stone is suitable for the manufacture of paving blocks, to which purpose alone it is applied. This is also true of a number of New England quarries. It will be noticed that in the older productive states the percentages of profit on capital and sales are fairly constant. The cost per cubic foot of the total product shows a decided variation, as would of course be expected from the complexity of the causes involved, such as ease or difficulty of quarrying, quality of stone, transportation facilities, cost of labor, and the great variation in the amount of manufacturing done upon the rough product. In the matter of the proportion which wages bear to the total expense of production it will be seen that in nearly all cases this is above 80 per cent, and in a few cases it constitutes almost the entire item of expense. In regard to the amount of wages paid per cubic foot, it should be borne in mind that these wages include all paid on the product up to the time it was sold by the producer, and inasmuch as it has been sold in all stages of finish, there is a correspondingly great variation in the wages paid per unit. Excessively high figures were paid in several western states in which production is just beginning, and in each of which there are only a very few operators. In the matter of ratio of wages to total value, the figures for the various states, except in those states where actual loss occurred, do not show a very great variation.

### GENERAL DEDUCTIONS.

| STATES AND TERRITORIES. | Total number of cubic feet. | Total value of product. | Total wages. | Total expenses. | Total capital. | PERCENTAGE OF PROFIT OR LOSS. |  | Cost of product per cubic foot. | Percentage of wages to total expense. | Wages paid per cubic foot. | Percentage of wages to total value. | Value per cubic foot. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  | On capital. | On value of products. |  |  |  |  |  |
| Total | 62, 287, 156 | $14, 464, 095 | $9, 620, 485 | $11, 504, 021 | $19, 115, 449 | 15. 49 | 20. 46 | $0. 18 | 83. 63 | $0. 15 | 66. 51 | $0. 23 |
| California | 4, 761, 411 | 1, 329, 018 | 809, 205 | 973, 276 | 2, 829, 794 | 12. 57 | 26. 77 | 0. 20 | 83. 14 | 0. 17 | 60. 89 | 0. 28 |
| Colorado | 2, 677, 465 | 314, 673 | 192, 700 | 214, 180 | 315, 485 | 31. 85 | 31. 94 | 0. 08 | 89. 97 | 0. 07 | 61. 24 | 0. 12 |
| Connecticut | 3, 835, 704 | 1, 061, 202 | 697, 080 | 813, 200 | 891, 889 | 27. 81 | 23. 37 | 0. 21 | 85. 72 | 0. 18 | 65. 69 | 0. 28 |
| Delaware | 1, 386, 431 | 211, 194 | 116, 216 | 191, 662 | 104, 545 | 18. 68 | 9. 25 | 0. 14 | 60. 64 | 0. 08 | 55. 03 | 0. 15 |
| Georgia | 2, 425, 622 | 752, 481 | 396, 461 | 472, 107 | 1, 481, 622 | 18. 92 | 37. 26 | 0. 19 | 83. 98 | 0. 16 | 52. 69 | 0. 31 |
| Maine | 6, 701, 346 | 2, 225, 839 | 1, 517, 026 | 1, 823, 976 | 3, 192, 317 | 12. 59 | 18. 05 | 0. 27 | 83. 17 | 0. 23 | 68. 16 | 0. 33 |
| Maryland | 3, 371, 032 | 447, 489 | 275, 566 | 351, 909 | 640, 448 | 14. 92 | 21. 36 | 0. 10 | 78. 31 | 0. 08 | 61. 58 | 0. 13 |
| Massachusetts | 9, 587, 996 | 2, 503, 503 | 1, 630, 128 | 1, 973, 729 | 2, 235, 759 | 23. 70 | 21. 16 | 0. 21 | 82. 59 | 0. 17 | 65. 11 | 0. 26 |
| Minnesota | 558, 200 | 356, 782 | 276, 859 | 295, 007 | 294, 218 | 21. 00 | 17. 31 | 0. 53 | 93. 85 | 0. 50 | 77. 60 | 0. 64 |
| Missouri | 1, 264, 317 | 500, 642 | 349, 208 | 425, 667 | 593, 100 | 12. 64 | 14. 98 | 0. 34 | 82. 04 | 0. 28 | 69. 75 | 0. 40 |
| New Hampshire | 2, 822, 026 | 727, 531 | 529, 945 | 597, 491 | 761, 362 | 17. 08 | 17. 87 | 0. 21 | 88. 70 | 0. 19 | 72. 84 | 0. 26 |
| New Jersey | 6, 374, 575 | 425, 673 | 294, 284 | 330, 644 | 418, 850 | 22. 69 | 22. 32 | 0. 05 | 89. 00 | 0. 05 | 69. 13 | 0. 07 |
| New York | 1, 515, 511 | 222, 773 | 182, 831 | 217, 160 | 422, 700 | 1. 33 | 2. 52 | 0. 14 | 84. 19 | 0. 12 | 82. 07 | 0. 15 |
| North Carolina | 708, 267 | 146, 627 | 101, 134 | 123, 937 | 255, 130 | 8. 89 | 15. 47 | 0. 17 | 81. 60 | 0. 14 | 68. 97 | 0. 21 |
| Oregon | 287, 400 | 44, 150 | 29, 860 | 37, 033 | 60, 600 | 11. 74 | 16. 12 | 0. 13 | 80. 63 | 0. 10 | 67. 63 | 0. 15 |
| Pennsylvania | 5, 782, 887 | 623, 252 | 441, 231 | 516, 923 | 930, 409 | 11. 43 | 17. 06 | 0. 09 | 85. 36 | 0. 08 | 70. 79 | 0. 11 |
| Rhode Island | 2, 878, 237 | 931, 216 | 618, 013 | 789, 219 | 646, 392 | 21. 97 | 15. 25 | 0. 27 | 78. 31 | 0. 21 | 66. 37 | 0. 32 |
| South Carolina | 214, 479 | 47, 614 | 22, 843 | 35, 028 | 143, 275 | 8. 78 | 26. 43 | 0. 16 | 65. 21 | 0. 11 | 47. 98 | 0. 22 |
| South Dakota | 786, 120 | 304, 673 | 216, 773 | 222, 229 | 444, 566 | 18. 54 | 27. 06 | 0. 28 | 97. 54 | 0. 28 | 71. 15 | 0. 39 |
| Texas | 20, 400 | 22, 550 | 20, 464 | 33, 738 | 212, 125 | *b*5. 27 | *b*49. 61 | 1. 65 | 60. 66 | 1. 00 | 90. 75 | 1. 11 |
| Utah | 123, 500 | 8, 700 | 7, 696 | 7, 846 | 18, 750 | 4. 55 | 9. 82 | 0. 06 | 98. 09 | 0. 06 | 88. 46 | 0. 07 |
| Vermont | 1, 073, 936 | 581, 870 | 408, 916 | 477, 114 | 967, 750 | 10. 82 | 18. 00 | 0. 44 | 85. 71 | 0. 38 | 70. 28 | 0. 54 |
| Virginia | 1, 703, 206 | 332, 548 | 218, 828 | 256, 125 | 446, 650 | 17. 11 | 22. 98 | 0. 15 | 85. 44 | 0. 13 | 65. 80 | 0. 20 |
| Wisconsin | 1, 385, 600 | 266, 095 | 221, 493 | 261, 791 | 546, 413 | 0. 79 | 1. 62 | 0. 19 | 84. 61 | 0. 16 | 83. 24 | 0. 19 |
| Other states (*a*) | 41, 488 | 76, 000 | 45, 725 | 63, 030 | 261, 300 | ........ | ........ | ........ | ........ | ........ | ........ | ...... |

*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Arkansas, Montana, Nevada, and Washington.

*b* Loss.

## METHODS OF QUARRYING GRANITE.

### STRUCTURE OF GRANITE IN PLACE.

The successful and economical working of granite quarries depends upon an intelligent application of a knowledge of the structure of the rock and its natural divisions in the mass, as well as upon improved methods, tools, and machinery for quarrying. The topographical location of the quarry and its relation to facilities for transportation are important factors that affect the productiveness and greatly modify the actual cost of operations in a given place.

In regions of great dynamic movement, such as most granite localities possess, very large rock masses without seams or fissures do not occur; but these fractures, extending, as they do, in certain definite directions to each other in the mass, form systems of inchoate joints, which divide it into roughly rectangular and rhombic forms, thus rendering valuable assistance to the quarryman. It is probable that the fissures were caused by pressure operating in certain directions during the origin or uplifting of the rock, and it is even possible for it to have been sufficient to change the molecular arrangement of the component minerals. Even those granites which are apparently normal, and which reveal no traces of stratification or parallel arrangement of mica or hornblende, are found by quarrymen and stonecutters to split more easily and with a smoother surface in one or more directions than in others. An unequal pressure operating on the mass would have caused certain directions or lines of weakness and account for this, or it may have produced the apparent rearrangement of the feldspar crystals, as found in a few of the granites. In northern New England particularly most of the fissures, as revealed by quarry openings, are slightly curved, parallel partings conforming in general to the direction of the slope upon which the quarry may be located. They produce a sheeted arrangement of the rock, which bends in ridges or curves in hilltops like anticlinal or quaquaversal folds of sedimentary strata. In addition to these divisional planes there occur one or more systems of vertical joints, the joints of each system running approximately parallel to each other, though the systems cross at varying angles.

It is interesting to note that the direction of easiest cleavage, called by quarrymen the "rift", is parallel to the most numerous natural fractures, and that at right angles to this another direction of cleavage, called the "grain", is parallel to the system having the next greatest number of joints. When the rift of the rock in place is horizontal or more nearly horizontal than perpendicular, it is customarily called the "lift". The grain, although important, is not generally an eminent feature, and its direction may remain unknown even for a long time after the quarry is opened. These systems of fracture, and the unequal ease of splitting in different directions, are points generally well understood and advantageously used by experienced granite workers.

### OPENING THE QUARRY.

Granite quarries are nearly always started in natural outcroppings of the ledge, but as they are entirely open workings, and necessarily cover large areas, considerable development work is needed at first and from time to time, as the quarry is enlarged, in stripping or clearing away the timber and soil and in removing the weathered portions or cap rock. It sometimes happens, especially in the northeastern region, that a ledge is found showing sound granite at the top, ready for quarrying, having been ground smooth by glacier movement and left bare of soil; but usually long exposed outcroppings have a softer outer portion, called "sap", resulting chiefly from the partial decomposition of the feldspar. This also occurs to a less extent along the seams and fissures, and where the rock contains iron the sap is stained by its oxidation to a brownish or reddish color. The sap may be merely a thin coating, scarcely discernible, or it may be that the rock is rendered unsound for 30 feet or more in depth, as is the case with a certain coarse-grained granite occurring in the Rocky mountains. The observation of such points in the field will serve as indications of the probable durability of the stone and the stability of its color.

### BLASTING.

Owing to great diversity in the structure of the rocks classed here as granite, the operations of quarrying necessarily vary considerably, even in different openings of the same region. The object desired is, however, the same in all, namely, the removal of large rectangular blocks with the least outlay of time and labor compatible with keeping the quarry in good working shape and avoiding waste. Ordinarily, to break the rock into sizes which can be handled, blasting is necessary. In doing this the object is to direct the force of the powder so that it may break the rock in the desired direction without shattering either the piece removed or the standing rock, but it can be successful only when it is detached at the ends and bottom and has a chance to move out in front. As the rift in the rock in the majority of quarries approaches the horizontal, the first breaks are obviously made either with or across the grain. The method most generally used for doing this is called "lewising", from the shape of the blast hole. A lewis hole is made by drilling close together holes about an inch and a half in diameter and in breaking down the partition between them by means of a flat steel bar, called a "set". This wide hole determines the direction of the required fracture. A "complex" lewis hole is the combination of 3 ordinary drill holes; a "compound" one, of 4; but the latter is seldom used, for if a very long break is to be made a series of lewis holes are drilled at considerable distances apart, and after being charged are fired simultaneously by means of an electric battery.

Another process occasionally used in a few quarries is as follows: a single round hole having been drilled, the explosive is put in, and on top of it an inverted iron wedge, placed between 2 half-rounds, is carefully lowered; then the tamping is proceeded with in the usual way. When the powder is exploded, the wedge, which is driven forcibly up between the half-rounds, breaks the rock in a direction corresponding to its thin end. One of the worst results of this procedure is that considerable rock near the top of the hole is apt to be huffed or flaked up.

Within a few years past the Knox system of blasting rock has been introduced and successfully used with general satisfaction in many of the larger quarries. The results obtained are those which were sought for by lewising, but the process is safer, quicker, takes less powder, and, as it never shatters the rock, not only gives good sound blocks as the product of the blast, but also leaves the standing rock with a perfectly sound, clean face for future operations. A round hole is first drilled to the required depth, and into this is driven a reamer, which produces V-shaped grooves at opposite sides to the entire depth of the hole. The charge is then inserted, and the tamping is done in the usual manner, except that instead of driving the tamping down upon the top of the charge an air space or cushion is reserved between the charge of powder and the tamping and as far above the charge as possible. The explosive has therefore the greatest possible chance for expansion before actually breaking the rock, the tamping being put down only to a sufficient depth to insure firmness of position. The result of this method is that the force of the explosive is directed in the line of the grooves, and no shattering of the rock occurs if it be solid, such as is common in ordinary blasting operations, and, as a consequence, quarrymen are enabled to get out stone of rectangular shape without waste or loss of valuable rock.

Very large blasts or mines are sometimes fired in quarrying granite. A shaft is sunk to the required depth, and from it drifts are run in various directions. These chambers, or drifts, are then charged with explosives and fired. In 1887, at Granite Bend, Missouri, stone enough was broken with 1 blast to supply the demands of a firm for 50 years. The shaft, which was 85 feet deep, had chambers running in several directions from the bottom, and was charged with 32,700 pounds of black powder.

The explosive used for breaking out dimension stone is black blasting powder, as its action is somewhat slower than that of the various forms of nitroglycerin, and there is consequently less danger of shattering the rock or of weakening it by starting incipient fractures that may not be detected until it is in place in a building; but for breaking up poor stone or for getting out rock regardless of size or form giant powder is frequently employed.

In a quarry having rather thin sheets and numerous vertical joints very good splits may be made with wedges driven between half-rounds (plug and feather) into small holes drilled a few inches apart along a prescribed line, every few feet a deeper hole of a somewhat larger dimension being drilled to guide the fracture; but this process is chiefly used for subdividing the blocks after they have been loosened by powder and for initial splits in quarries where the drift is vertical.

Drills driven either by steam or compressed air are in use for making blast holes in all the principal quarries. The drill is connected with the piston, which is supported by a portable iron tripod, carrying the necessary appliances for regulating its movements. A flexible pipe conveys the motive power in the form of compressed air or steam.

In smaller quarries these holes are drilled by the "jumper" drill, a long, flat-edged steel bar, which a man holds and turns as it rebounds slightly after each of the swinging blows dealt it by heavy sledges.

Steam channeling machines, common in large marble and sandstone quarries, are used on granite by a few quarriers chiefly for making end cuts in stone of exceptional structure, but only to a limited extent, since the great hardness of granite renders the process very slow and expensive.

The large blocks loosened by blasting are broken and split into sizes of the required approximate dimensions by the plug-and-feather method. The holes, which are of small diameter, generally not more than three-fourths of an inch, and a few inches only in depth, are made by a drill and hand hammer. Into each hole is inserted 2 half-rounds or "feathers", tapering pieces of iron, flat on one side and rounded on the other, between which is placed a steel plug or wedge. The wedges are then driven in with a sledge till the strain is sufficient to split the rock.

## METHODS OF CUTTING, POLISHING, AND ORNAMENTING GRANITE.

Only a small percentage of granite in rough blocks as it leaves the quarry proper is available for use in this form. Most of it has to be cut to the desired dimensions and brought to the degree of finish required for the special purposes for which it is to be used. Very large blocks and stone designed for uses not requiring fine finish are often worked in the open air, but most quarries have cutting sheds erected near the openings, in which the blocks are worked into their intended form. These sheds vary from merely a rough covering of boards to extensive buildings.

To produce good results great skill is needed by the stonecutter in the manipulation of his tools, and considerable artistic ability is required for the finer kinds of work. From the rough work of simply splitting a block or rudely spalling an ashlar face to the artistic working of highly embellished and complicated statuary carving a knowledge of the rift and grain is important, as it indicates where heavy blows may be struck and where lighter ones are required.

Owing to the great obduracy of this stone and the fact that the different minerals composing it vary greatly in hardness, the chief work of shaping it is still performed by hand, probably by much the same process that was used by Egyptian stonecutters more than 3,000 years ago. Improvements and inventions have, however, been made from time to time in hand tools, and extensive machinery is now in use for producing certain forms and kinds of finish.

### RECENT IMPROVEMENTS.

The most important improvements of the last decade include the more extended adoption of lathes for turning and polishing columns, urns, etc., and new devices in power machinery for plain polishing. Greater economy and speed are now obtained by the general use of chilled iron globules and crushed steel as abrasive materials and of the pneumatic tool for the ornamentation of surfaces.

### GRANITE FOR BUILDING PURPOSES.

By reference to the table giving the output of granite according to purposes it will be seen that more stone was used for building than for any other purpose. A great amount of labor by the stonecutter is necessary to fit it for its destined place, but much of this work consists in merely squaring up or subdividing the large blocks as hauled from the quarry opening. Much more work is needed on the stone to be used for fronts, trimmings, and certain portions of superstructures, while for special parts, such as polished columns and ornate keystones and capitals, the greatest skill and longest time are required. The general processes of finer finish will, however, be mentioned further on in connection with cemetery, monumental, and decorative purposes, although all stone designed for superstructures, whether rough or finely wrought, has been tabulated under the heading "Building purposes".

### IMPLEMENTS FOR CUTTING.

The implements used by stonecutters to produce common forms and ordinary finish are as follows:

Chisel.—Various forms and sizes are employed in cutting border drafts, moldings, letters, and ornamental work.

Point.—A piece of steel bar drawn out to a pyramidal end; used for "roughing out" surfaces and removing "bunches".

Hand drills, wedges, and half-rounds.—Used for splitting out blocks.

Hand hammer.—Used in one hand for driving chisels, points, and drills, which are held and guided by the other.

Spalling hammer.—A heavy square-cornered sledge, used for roughly reducing a block by breaking off large chips or spalls from the edges, thus bringing it closer to its intended form.

Pean hammer.—Shaped like a double-edged wedge, with a handle running parallel with the edges; used to remove irregularities by striking squarely upon a surface and wedging or bruising off small chips.

Bush hammer.—Made of rectangular steel plates brought to an edge, bolted together, and attached to a long handle; used in the same manner as the pean hammer, but produces a smoother surface, the degree of smoothness depending upon the number of steel plates in the particular hammer used. These hammers, which are all of the same thickness, are called 4-cut, 5-cut, 6-cut, 8-cut, 10-cut, and 12-cut, according to the number of plates used in their construction.

The size, shape, and finish of a stone depend upon the particular place it is to occupy in a building and the style of architecture. Fronts or walls are laid up in various kinds of ranges, usually designated as coursed range, broken range, broken ashlar, random range, and rubble work. The kind of finish given the face of the stone is called either bush hammered, pean hammered, pointed work, or rock face. These may or may not have a border draft chiseled around their margins. Other kinds of finish are chiseled moldings and carved or polished faces.

The usual process followed by stonecutters in shaping blocks may be generalized as follows: The block, having been split out to about the right size by the plug-and-feather method, is brought to a plane surface on 1 side, which is accomplished by knocking off overhanging edges and projections with the spalling hammer or spalling tool. Drafts or ledges are then chiseled along 2 opposite edges. 1 draft being completed, the workman lays upon it a wooden strip or rule having parallel edges. A second rule is then sunk in the draft made on the opposite side until the 2 drafts are in the same plane, which is determined by sighting across the upper edges of the rules. The whole face is then worked down to this plane with the tools necessary for the required fineness of finish, a straightedge being applied from time to time as the work progresses. The point is used for removing rougher projections. This is followed by the pean hammer, and, if a smoother surface is required, it is made by bush hammering, the hammer having the fewest number of plates being used first. The required size of the face being marked out upon this surface, the position of a second face may be determined by chiseling drafts across the ends of an adjacent surface, using for the purpose either a square or a bevel, depending upon the angle it is desired to make with the first face. The projecting rock between the drafts having been removed in the manner used in forming the first surface, a third face may be projected. A winding surface is formed by using in 1 draft a rule or strip having its opposite edges not parallel, the amount of divergence depending upon the amount of warp required. This rule is sunk till its upper edge is even with the upper edge of the strip, having parallel edges placed upon the opposite edge of the stone.

A cylindrical surface is worked by using curved rules in one direction, and is not as hard a matter as might at first seem. Much difficulty is, however, encountered in laying out and working spiral, conical, and spherical surfaces, as it is first necessary to form plane and cylindrical faces on which to apply the necessary bevels and templets.

## GRANITE FOR STREET WORK.

### PAVING BLOCKS.

Experience has demonstrated that the best and most enduring streets for heavy traffic in large cities are those paved with stone blocks of proper material and size, laid upon a specially prepared bed. The very hard and tough rocks frequently used, though capable of withstanding a maximum amount of wear, soon become smooth and glazed under traffic, and are therefore inferior to a stone which, wearing roughly, affords a better foothold for horses. Many of the granite rocks possess the right degree of hardness and brittleness, and are largely used for this purpose. This industry has increased largely since 1880, the number of granite blocks made in 1889 in the various states aggregating nearly 62,000,000.

Streets paved with the large-sized block used at first were found to be more difficult to keep in repair, worse for horses, and rougher on vehicles than pavements made of the smaller blocks now in general use. There is no uniform standard of size, as specifications of the various cities call for different sizes, but the variations are not great, and blocks 3½ to 4½ inches wide, 6 to 7 inches deep, and 8 to 12 inches long are generally preferred. In New York city, Brooklyn, and Philadelphia blocks a trifle longer are more commonly used, while in many of the western and southern cities the length does not exceed 10 inches. New Orleans, owing to the peculiar nature of its streets, takes blocks much larger.

The manufacture of paving blocks, though an important adjunct of the granite business, varies nevertheless, for obvious reasons, in many of its details from the ordinary methods of granite cutting. The high skill and fine workmanship of the stonemason are not needed, but a quickness in seeing and taking advantage of the directions of cleavage, as well as a deftness in handling the necessary tools, is requisite.

Specifications call for blocks so quarried or dressed as to present substantially rectangular faces with practically straight edges. The corresponding dimensions of opposite faces must not vary more than one-half inch, and the surface must be free from bunches, depressions, and inequalities exceeding one-half inch.

The tools used for making blocks are knapping hammers, opening hammers, hand hammers, reels, chisels, and, for initial splits, drills, wedges, and half-rounds. When the block maker quarries his own stock it is called "motion work", and the same process is used as in quarrying stone for other purposes, except that, as large blocks are not required, most of it can be done with plug and feather.

Slabs, having been split out in the usual manner to sizes that may be easily turned over and handled by 1 man, are subdivided into pieces corresponding approximately to the dimensions of the required blocks. This is done by striking repeated blows upon the rock along the line of the desired break with heavy knapping and opening hammers. When a break is to be made crosswise the grain, it is frequently necessary to chisel a light groove across 1 face, and commonly across the adjacent sides, to guide the fracture produced by striking on the opposite surface with the opening hammer. Good splits can, however, be made along either the rift or grain by the skillful use of the opening hammer alone. Blocks broken out in the manner described are trimmed and finished with the reel, which is a hand hammer having a long, flat steel head attached to a short handle. Block breakers become very expert in the use of this instrument, and without making any measurements turn out in a surprisingly short time a large number of blocks. In Maine, which is far ahead of any other state in the number of blocks made, the entire product of many quarries is used for this exclusive purpose. This is also the case in California, which comes second, though the blocks are manufactured chiefly from the surface "bowlders" or detached masses of basalt so common in Sonoma county. Other quarries, however, in various parts of the country utilize only the "grout", small or irregular shaped pieces, for making paving block, and haul the stock to the breakers, who work in sheds; but the greatest number of blocks is made on the spot where the rock is quarried, the workmen being protected during the hottest months by a temporarily spread canvas fly.

Blocks are counted as they are thrown into the cart which is usually needed to haul them to the shipping point. Several paving-block quarries in Maine are situated on steep mountain slopes so near water communication that blocks may be slid in long board chutes from the quarry directly into the hold of the vessel used for their transportation.

Paving breakers seldom work by the day, but are paid a certain sum per thousand for making the blocks, the price paid in 1889 ranging from $22 to $30, according to the size of block made, kind of stone used, locality, and whether the tools were furnished and the blocks quarried by their employers. Workmen using their own tools are commonly paid $1 more per thousand for the blocks made, and when they quarry the stock they use from $2 to $5 per thousand is allowed in addition.

### CURBING AND BASIN HEADS.

Next in importance to the manufacture of paving blocks, in the division of granite for street work, is the production of long granite slabs for curbstone. Granite, having a free rift, is preferred for this purpose on account of its better working qualities. The dimensions of ordinary curbstones are from 6 to 12 feet long, 6 to 8 inches thick, and about 2 feet deep. The top edge is made full and square and neatly bushhammered. The face is also bushhammered down about a foot from the top. The ends are dressed smooth, so as to make close joints, and the back of the stone, which is placed next to the sidewalk, is also dressed a few inches from the top.

### OTHER USES.

Other applications of granite to street work are for flagstone, for crosswalks laid at the intersection of streets, and for gutter stone, but these are dressed, when required, in the usual manner, and need no special comment here.

Granite is largely used for making macadam and telford roads and concrete and artificial stone pavements, though it is seldom quarried expressly for this purpose, but made of spalls, grout, and waste from other quarries. The pieces are broken with sledges where coarse stones are needed, or run through power rock breakers when a finer subdivision is required.

## GRANITE FOR CEMETERY, MONUMENTAL, AND DECORATIVE PURPOSES.

A considerable portion of the stone for these uses, especially for small-sized monuments, tombstones, and grave markers, is shipped from the quarries in rough blocks, which are suitably shaped and finished by masons working in town shops or stone yards. Large monuments and large polished blocks for buildings, columns, pilasters, and statuary are generally worked at quarry sheds, polishing mills, or shops not far distant.

There has been a decided increase in the use of polished granite for cemetery purposes since the introduction of machinery for its polishing, which has greatly decreased the price for this kind of finish. For these, as well as for all purposes where a polished surface is desired, as bottom courses in buildings, columns, pilasters, wainscoting, etc., the red, pink, dark gray, and black varieties are in high favor, since they have a richer look and present a much greater contrast between a hammered or chiseled surface and a polished one; but for granite statuary and ornately carved building blocks, and for all purposes where it is desirable to present fine detail, it is necessary that the granite be of a light color, fine grained, and easily worked to secure the best results.

### POLISHED GRANITE.

The varieties of granite susceptible of the highest and most enduring polish are those containing the largest percentages of the hard minerals, quartz and feldspar, quartz being especially important. Hornblende, however, takes a fairly good polish, and contributes largely to the coloring of most dark granites. Pyroxene of the type occurring in the Quincy granites is rather bad, since, owing to its brittleness, it cracks out more or less and leaves small pits in the finished face. Much mica, especially in large plates, is objectionable, as it will not polish, but remains dull and lusterless except where the direction of its cleavage planes happen to coincide with the face of the stone.

After being prepared by bushhammering, the block is transported to the shop or mill to receive further smoothing and its final finish. The surface to be worked upon is brought to a horizontal position and ground smooth with an abrasive material mixed with water and moved about by a revolving iron or steel disk perforated with holes or made of concentric rings. This disk, which is 12 or 14 inches across, is revolved by an upright shaft, to the bottom of which it is fastened, and the power is communicated through a main shaft running overhead. Joints in the upright or counter shaft and its peculiar attachment to the main shaft allow its lower end to be swung over a considerable area, thus permitting the workman who guides it to move it over a surface of stone many times larger than the disk itself.

The abrasive material now almost exclusively used for grinding granite is either chilled iron globules, steel emery, or crushed steel. A coarse grade is used at first, then a finer kind, and for the last grinding fine emery is often used. Polishing is done in much the same way as grinding, except that a felt-covered disk is used in place of an iron one, and putty powder, mixed with a little water, instead of coarser grinding materials. Before the final polish, however, the surface is usually given a dull gloss or "skin coat" by the disk and water alone. A polish is sometimes produced by the use of oxalic acid instead of putty powder, but the polish thus made is less durable. Moldings are ground and polished by means of blocks fitting the grooves dragged back and forth either by power or hand.

Granite for columns, balusters, round posts, and urns is now worked chiefly in lathes, which for the heaviest work are made large enough to handle blocks 25 feet long and 5 feet in diameter. Instead of being turned to the desired size by sharp cutting instruments, as in ordinary machines for turning wood and metal, granite is turned or ground away by the wedge-like action of rather thick steel disks, rotated by the pressure of the stone as it slowly turns in the lathe. The disks, which are 6 or 8 inches in diameter, are set at quite an angle to the stone, and move with an automatic carriage along the lathe bed. Large lathes have 4 disks, 2 on each side, and a column may be reduced some 2 inches in diameter the whole length of the stone by 1 lateral movement of the carriages along the bed. The first lathes for turning granite cut only cylindrical or conical columns, but an improved form is so made that templets or patterns may be inserted to guide the carriages, and columns having any desired swell may be as readily turned. For fine grinding and polishing, the granite is transferred to another lathe, where the only machinery used is to produce a simple turning or revolution of the stone against iron blocks carrying the necessary grinding or polishing materials.

Blocks are prepared for lathe work by being roughed out with a point, and by having holes chiseled in their squared ends for the reception of the lathe dog and centers. This principle of cutting granite by means of disks revolved by contact with the stone has been also applied to the dressing of plain surfaces, the stone worked upon being mounted upon a traveling carriage and made to pass under a series of disks mounted in a stationary upright frame.

Tracery and lettering for polished granite are usually first drawn upon paper, which is firmly pasted to the surface, and the design chiseled through it to the requisite depth in the rock.

### CARVED GRANITE.

Statues, capitals, keystones, and, in general, all highly ornamental designs, are worked out with chisels from detail drawings or plaster casts. It is necessarily a slow process, owing to the hardness of the rock, and the cost of such work is consequently great. A pneumatic tool, however, which has been recently patented and successfully applied to this purpose gives promise of superseding much of the tediousness of the hand process. This instrument is connected to a flexible pipe, supplying the compressed air or steam by which it is driven, and works at a remarkably high rate of speed. It may be moved to any part of a surface, and works with a celerity unapproached by other means.

The use of granite for sculpture is steadily increasing, particularly for outdoor statuary. The white, fine-grained muscovite-biotite granite found at Hallowell, Manchester, and Augusta, in Maine, is particularly well adapted for this purpose. Statues made of the Hallowell granite are to be found in nearly every state, though possibly the stone is not superior to varieties found in other localities.

# MARBLE.

## CHARACTERISTICS OF THE INDUSTRY.

Considering the widespread occurrence of stone adapted to building and other purposes, it is natural to regard quarrying as practicable in almost any locality, and, consequently, to consider stone quarrying as a practically universal industry. This view is correct when limited to the ordinary coarser kinds of stone. Quarries producing stone of one sort or another are found scattered over all portions of the United States. In the marble branch of the industry, however, the case is different, inasmuch as this kind of stone is found only in comparatively few localities. It is only here and there that the metamorphosing influences of heat and pressure have transformed portions of the vast and widely distributed limestone deposits into marble. Among these sporadic deposits of marble it is the exception to find masses reasonably easy of access, sufficiently strong, of good color, and satisfactory in crystalline condition and freedom from flaws. Serious shortcomings in regard to any of these conditions may mean financial disaster to the would-be quarrymen.

Thus it happens that marble is obtained from only 12 states, and of these Vermont has yielded more in value than all the others together.

Limestone and marble, although closely related from the chemical standpoint, are very different in physical structure and purity. The uses to which they are put are so strongly contrasted that from a commercial point of view they are far from having anything in common, except in cases where refuse fragments of marble are used for rough building, road ballast, or burning into lime, purposes for which common limestone is freely employed. For these reasons, therefore, a careful distinction has been observed between common uncrystallized limestone on the one hand and crystallized and otherwise metamorphosed limestone, that is, marble, on the other. Statistics of a few quarries producing serpentine and verd antique have been included in this report, because the purposes for which they are used are identical with those to which pure marble is applied, such as interior decoration in buildings and in furniture manufacture.

The following statements have been compiled for the purpose of showing the present condition of the industry strictly from the standpoint of a census; that is, to show its part of the total mineral product of the country, the amount of capital which has been invested in the enterprise, the number of persons whose livelihoods are concerned, their condition, and the peculiar features essential to a successful prosecution of the business.

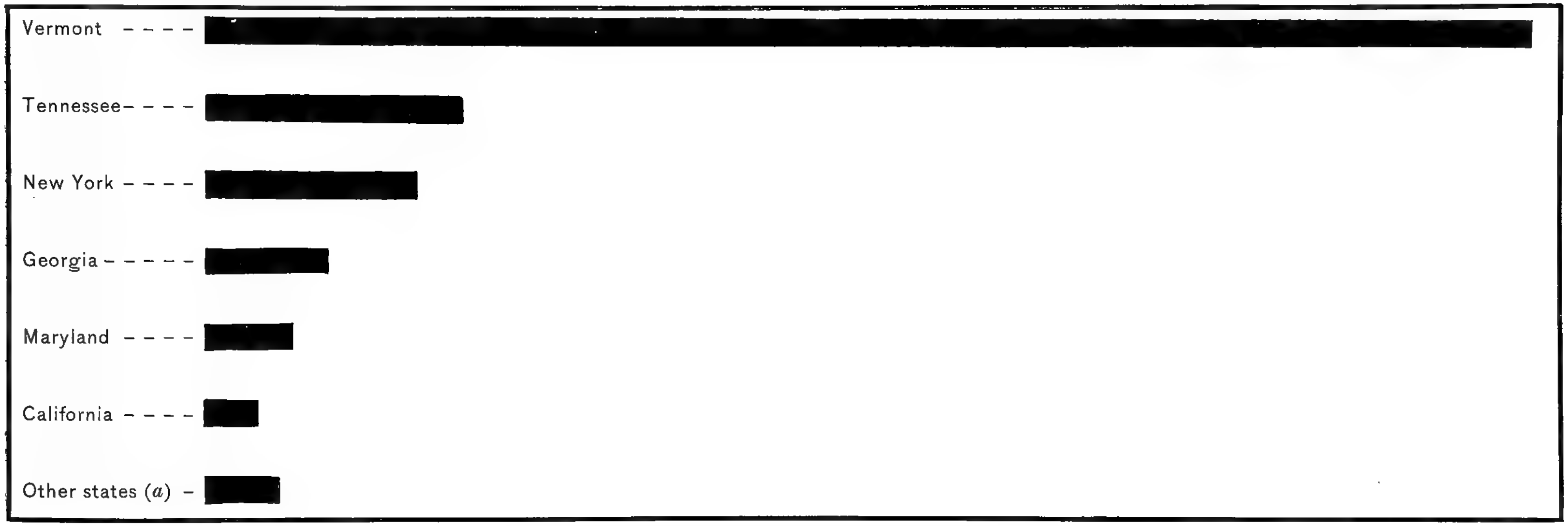
## PRODUCTION.

In order that the statistics herein contained may be clearly understood, a few words of explanation are necessary. The figures representing the value of the marble product are the aggregate of the prices received at the quarries or mills by the individuals or firms operating quarries. In other words, this value is what the producers receive for their output, whether rough or manufactured, eliminating all freight on the product sold. In some cases quarrymen have sold the product of their quarries in the rough to stonecutters, who have then prepared it for the consumer. In these cases the value is the price received by quarrymen for the rough stone. In other instances, however, quarrymen operating their own mills and finishing shops have sold stone ready for the consumer, and the price received by them for the product thus finished is the value of their output. The tendency at present is for quarrymen to do their own finishing and to sell the product ready for the consumer, but this practice is not yet universal.

The total value of all marble produced by quarrymen in 1889, as shown by the table on page 619, was $3,488,170. According to Mineral Resources of the United States, 1888, page 541, the value of the marble produced during that year was $3,000,000. The year 1888, while falling somewhat below the preceding year in actual production, was pre-eminently one of preparation for the future, inasmuch as several new enterprises were started and important additions to a number of already existing plants were made. The gain in value of nearly $500,000 in 1889 is therefore not surprising.

The expenses of producing the marble include all wages and other outlays involved in getting it into the shape, whether rough or finished, in which it first became marketable; that is to say, they include not only wages paid to laborers in the quarry, but also wages paid to mill men and stonecutters, if such were employed by the quarry

Eleventh Census of the United States. Robert P. Porter, Superintendent.



RELATIVE RANK OF STATES PRODUCING MARBLE.

*a* Idaho, Massachusetts, New Mexico, Pennsylvania, Utah, and Virginia.

operator. The capital invested includes not only that applied to quarries and quarrying operations, but also to that invested in mills and finishing shops, provided they were operated by quarrymen. Likewise the number of men employed includes not only those engaged in quarrying operations, but also all connected with mills operated by quarrymen.

## PRODUCTION OF MARBLE IN 1889, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | Number of individuals or firms operating quarries. | Number of quarries operated. | PRODUCT. | | LABOR. | | | | | | | POWER. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Number of employés. | | | | | | | | | | |
| | | | Cubic feet. | Total value. | Total number employed. | Foremen. | Quarrymen and millmen. | Mechanics. | Laborers. | Boys under 16 years. | Office force. | Number of boilers. | Total horse power of boilers. | Horse power of water wheels. | Number of animals employed. |
| Total | 74 | 103 | 3, 320, 213 | $3, 488, 170 | 4, 529 | 158 | 2, 185 | 1, 021 | 1, 013 | 56 | 96 | 206 | 8, 022 | 3, 370 | 693 |
| California | 4 | 4 | 33, 792 | 87, 030 | 62 | 4 | 27 | 16 | 10 | 1 | 4 | 2 | 120 | 10 | 16 |
| Georgia | 3 | 7 | 250, 000 | 196, 250 | 264 | 11 | 110 | 20 | 116 | 4 | 3 | 23 | 940 | ........ | 25 |
| Maryland | 3 | 3 | 333, 305 | 139, 816 | 206 | 10 | 153 | 10 | 16 | 12 | 5 | 15 | 700 | 75 | 24 |
| New York | 13 | 14 | 1, 171, 550 | 354, 197 | 406 | 17 | 200 | 91 | 83 | 4 | 11 | 31 | 1, 241 | ........ | 75 |
| Tennessee | 22 | 29 | 309, 709 | 419, 467 | 755 | 28 | 557 | 92 | 45 | 27 | 6 | 29 | 695 | ........ | 102 |
| Vermont | 22 | 36 | 1, 068, 305 | 2, 169, 560 | 2, 716 | 81 | 1, 078 | 768 | 715 | 8 | 66 | 90 | 4, 011 | 3, 285 | 423 |
| Other states and territories (*a*) | 7 | 10 | 153, 552 | 121, 850 | 120 | 7 | 60 | 24 | 28 | ...... | 1 | 16 | 315 | ........ | 28 |

| STATES AND TERRITORIES. | EXPENSES. | | | | CAPITAL INVESTED. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total expenses incurred in producing entire amount of marble. | Total wages, including salaries paid to office force. | Value of supplies and materials consumed. | All other expenditures for the quarries, such as rent, taxes, insurance, interest, etc. | Total capital. | In land. | In buildings and fixtures. | In tools, live stock, machinery, and supplies on hand. | In cash. |
| Total | $2, 675, 069 | $1, 809, 211 | $655, 586 | $210, 272 | $15, 092, 842 | $8, 828, 960 | $2, 130, 415 | $1, 876, 265 | $2, 257, 202 |
| California | 72, 715 | 43, 615 | 28, 500 | 600 | 554, 000 | 350, 500 | 90, 300 | 102, 700 | 10, 500 |
| Georgia | 147, 086 | 76, 661 | 33, 175 | 37, 250 | 2, 373, 627 | 2, 038, 790 | 126, 750 | 190, 350 | 17, 737 |
| Maryland | 112, 504 | 78, 240 | 18, 847 | 15, 417 | 576, 904 | 259, 400 | 50, 890 | 119, 914 | 146, 700 |
| New York | 260, 804 | 182, 641 | 52, 756 | 25, 407 | 1, 033, 461 | 621, 550 | 121, 600 | 195, 459 | 94, 852 |
| Tennessee | 263, 741 | 213, 214 | 29, 150 | 21, 377 | 815, 500 | 544, 695 | 36, 600 | 133, 192 | 101, 013 |
| Vermont | 1, 739, 988 | 1, 163, 973 | 471, 836 | 104, 179 | 9, 346, 928 | 4, 746, 300 | 1, 654, 200 | 1, 076, 528 | 1, 869, 900 |
| Other states and territories (*a*) | 78, 231 | 50, 867 | 21, 322 | 6, 042 | 392, 422 | 267, 725 | 50, 075 | 58, 122 | 16, 500 |

*a* The states and territories here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Idaho, Massachusetts, Pennsylvania, Virginia, New Mexico, and Utah. In New Mexico and Utah there was preparatory work only, no product having been sold in 1889.

## EMPLOYÉS IN MARBLE QUARRYING, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | FOREMEN. | | QUARRYMEN AND MILLMEN. | | MECHANICS. | | LABORERS. | | BOYS UNDER 16 YEARS. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Average number days employed. | Average daily wages. | Average number days employed. | Average daily wages. | Average number days employed. | Average daily wages. | Average number days employed. | Average daily wages. | Average number days employed. | Average daily wages. |
| Total | 276 | $2. 87 | 252 | $1. 26 | 264 | $1. 98 | 258 | $1. 28 | 226 | $0. 66 |
| California | 273 | 4 31 | 255 | 2. 55 | 286 | 2. 86 | 190 | 2. 12 | 300 | 1. 25 |
| Georgia | 282 | 2. 44 | 284 | 1. 01 | 255 | 1. 61 | 237 | 0. 86 | 215 | 0. 50 |
| Idaho | ........ | ........ | 50 | 2. 00 | 100 | 5. 00 | 200 | 1. 50 | ........ | ........ |
| Maryland | 279 | 3. 00 | 245 | 1. 38 | 290 | 2. 54 | 257 | 1. 20 | 250 | 0. 90 |
| Massachusetts | 275 | 2. 00 | 260 | 1. 50 | 260 | 2. 25 | 260 | 1. 50 | ........ | ........ |
| New Mexico | ........ | ........ | 50 | 3. 00 | ........ | ........ | ........ | ........ | ........ | ........ |
| New York | 271 | 2. 86 | 237 | 1. 39 | 227 | 3. 00 | 251 | 1. 39 | 250 | 1. 00 |
| Pennsylvania | 313 | 1. 80 | 290 | 1. 46 | 313 | 1. 50 | ........ | ........ | ........ | ........ |
| Tennessee | 212 | 2. 65 | 234 | 1. 12 | 239 | 1. 57 | 225 | 1. 04 | 213 | 0. 47 |
| Utah | ........ | ........ | ........ | ........ | ........ | ........ | 75 | 3. 50 | ........ | ........ |
| Vermont | 272 | 3. 00 | 262 | 1. 27 | 270 | 1. 87 | 265 | 1. 33 | 220 | 0. 75 |
| Virginia | 285 | 1. 92 | 284 | 1. 41 | 285 | 2. 65 | 284 | 1. 00 | ........ | ........ |

### GENERAL STATEMENTS CONCERNING PRODUCTION.

It will be found impossible to obtain an accurate idea of the growth of the marble industry for the past decade by comparing the figures in the tables with those published in the census report of 1880, because in that report marble and limestone were considered together, while in the present census they are treated separately. The volume entitled Mineral Resources of the United States, 1886, page 541, contains, however, a table specially compiled by Mr. George P. Merrill, of the National Museum, which shows the value of the marble for 1880, exclusive of common limestone, to be $2,033,595. According to this there has been a gain since 1880 of $1,454,575, or 72 per cent. The table for 1880 is presented, as follows:

VALUE OF MARBLE QUARRIED IN 1880, BY STATES.

| | |
|---|---|
| Vermont | $1, 340, 000 |
| New York | 224, 500 |
| Massachusetts | 230, 495 |
| Maryland | 65, 000 |
| Tennessee | 173, 600 |
| Total | 2, 033, 595 |

Of the 12 productive states, Vermont, with its production of 62 per cent of the total output, has always been by far the most important. The following states, in the order of the value of the output, are the next in importance: Tennessee, New York, Georgia, Maryland, California, and Virginia. The product of each of the remaining 6 states was valued at less than $50,000. From the states named in the table, therefore, the entire supply of marble used in the United States is obtained, with the exception of that imported into the country. The value of the marble imported in 1889 was $701,518, so that 83 per cent of the entire consumption is supplied from this country. The figures in the first table show the number of individuals, excluding office force, employed by marble producers in the United States to be 4,433. Of this number 56 are boys under 16 years of age. Dividing the total wages paid in 1889, as shown in the first table, $1,809,211, by the total number of individuals employed, $400 is obtained as the average annual amount received by each individual, and dividing $400 by the average number of days employed for all classes of labor, namely, 255, it becomes evident that the average daily wages for the total number of persons employed is $1.57. Again, if the average wages be computed from the statements given in the second table, which are the figures furnished by the producers, the daily average is $1.61, thus showing a very satisfactory agreement between the wages reported as actually paid in the first table and the entirely independent average statements given in the second table.

### IMPORTS.

Italian marble, principally Carrara, forms over three-fourths of the total imports. A small proportion is Mexican onyx. Small annual imports of marble for special purposes come from France and French possessions. Austria-Hungary, England, Germany, Canada, Turkey in Asia, Ireland, and Scotland furnish occasional shipments.

The figures in the following table are compiled from the reports of the bureau of statistics of the Treasury department:

MARBLE IMPORTED AND ENTERED FOR CONSUMPTION IN THE UNITED STATES, 1867 TO 1883, INCLUSIVE.

| YEARS ENDED— | Sawed, dressed, etc., not over 2 inches in thickness. | Sawed, dressed, etc., over 2 and not over 3 inches in thickness. | Sawed, dressed, etc., over 3 and not over 4 inches in thickness. | Sawed, dressed, etc., over 4 and not over 5 inches in thickness. | Sawed, dressed, etc., over 5 and not over 6 inches in thickness. | Veined and all other, in blocks, etc. | White, statuary, brocatel, etc. | Not otherwise specified. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| June 30, 1867 | | | | | | $192, 514 | $2, 540 | $51, 978 | $247, 032 |
| 1868 | | | | | | 309, 750 | 4, 403 | 85, 783 | 399, 936 |
| 1869 | | | | | | 359, 881 | 3, 898 | 101, 309 | 465, 088 |
| 1870 | | | | | | 332, 839 | 3, 713 | 142, 785 | 479, 337 |
| 1871 | $5, 973 | $168 | $77 | $44 | $28 | 400, 158 | 1, 134 | 118, 016 | 525, 598 |
| 1872 | 3, 499 | 1, 081 | 452 | | 318 | 475, 718 | 4, 017 | 54, 539 | 539, 624 |
| 1873 | 3, 124 | 21 | | | | 396, 671 | 4, 148 | 69, 991 | 473, 955 |
| 1874 | 1, 837 | | | | | 474, 680 | 2, 863 | 51, 699 | 531, 079 |
| 1875 | 1, 456 | 427 | 96 | | | 527, 628 | 1, 623 | 72, 389 | 603, 619 |
| 1876 | 595 | 126 | 203 | 87 | | 529, 126 | 1, 151 | 60, 596 | 591, 884 |
| 1877 | 2, 124 | | | | | 349, 590 | 1, 404 | 77, 293 | 430, 411 |
| 1878 | 198 | 11 | 8 | | | 376, 936 | 592 | 43, 915 | 421, 660 |
| 1879 | 184 | | | | | 329, 155 | 427 | 54. 857 | 384, 623 |
| 1880 | | | | | | 531, 908 | 7, 239 | 62, 715 | 601, 862 |
| 1881 | 339 | | | | | 470, 047 | 1, 468 | 82, 046 | 553, 900 |
| 1882 | 655 | | | | | 486, 331 | 3, 582 | 84, 577 | 575, 145 |
| 1883 | 619 | | | | | 533, 096 | 2, 011 | 71, 905 | 607, 631 |

During the calendar years ended December 31, from 1886 to 1889, and fiscal years ended June 30, for 1884 and 1885, the classification of marble has been as follows:

| CLASSIFICATION. | 1884. | 1885. | 1886. | 1887. | 1888. | 1889. |
|---|---|---|---|---|---|---|
| Total | $592, 057 | $527, 881 | $549, 573 | $529, 933 | $534, 263 | $701, 518 |
| Marble in blocks, rough or squared, of all kinds | 511, 287 | 429, 186 | 408, 895 | 355, 648 | 357, 220 | 498, 274 |
| Veined marble, sawed, dressed, or otherwise, including marble slabs and marble paving tiles. | 12, 941 | 43, 923 | 96, 625 | 142, 405 | 107, 957 | 115, 909 |
| All manufactures of marble not specially enumerated | 67, 829 | 54, 772 | 44, 053 | 31, 880 | 69, 086 | 87, 335 |

## THE MARBLE INDUSTRY IN INDIVIDUAL STATES.

The following considerations apply to individual states, and are presented for the purpose of placing on record items of information which may be found interesting to marble quarrymen as well as to statisticians. The states are arranged in the order of the value of their output.

### VERMONT. (*a*)

The producing counties are, in the order of their importance, Rutland, Bennington, Franklin, and Addison, the total value of the product being $2,169,560. These counties are all in the western part of the state, and, interrupted only by Chittenden county, extend from the Dorset quarries in the southwest corner to the Champlain marbles at Swanton, in the extreme northern part. The quarries now operated are found in or near the towns of Manchester, Dorset, East Dorset, Wallingford, Rutland, West Rutland, Proctor, Pittsford, Brandon, Fair Haven, Middlebury, North Ferrisburg, and Swanton. Abandoned quarries are found all along the railroad line from Dorset to Middlebury. Most of the quarries are near railroad lines, but in some cases it is necessary to haul by wagon to the nearest railroad station. The longest distance of such transportation is 7 miles.

The marble lies in irregular beds, extending north and south, and having a slight dip toward the west, but at West Rutland the angle is very much increased, amounting to 80°, and the marble is worked to a depth of 300 feet. In most cases the upper layers are of little value, and the marble can only be used for purposes requiring rough stone, regardless of composition. 10 or 12 feet of surface rock must be thrown away before sound material is reached.

There is considerable variety in the color as well as in the texture of the stone. The pure white marble is rare, occurring in layers of very limited extent. Most of the stone is of a bluish-gray tone, and presents a mottled or clouded appearance, resulting from a more or less intimate mixture of blue and white. In some cases the blue is so predominant that the marble is known as "blue marble", and in cases where the blue is particularly pronounced it is called "extra dark blue". The pure white statuary marble is generally found at considerable depth. There is, however, no decided regularity in the relative arrangement of the different colors. The following analyses made at Yale University for the Columbian Marble Company may be regarded as representative of the marbles of the colors named:

#### ANALYSES OF MARBLE FROM PROCTOR, VERMONT.

DARK-COLORED MARBLE.

| | PER CENT. |
|---|---|
| Calcium carbonate | 98. 370 |
| Magnesium carbonate | 0. 790 |
| Iron carbonate | 0. 034 |
| Oxides of manganese and aluminum | 0. 005 |
| Matter insoluble in acids | 0. 630 |
| Organic matter | 0. 080 |
| Total | 99. 909 |

LIGHT-COLORED MARBLE.

| | |
|---|---|
| Calcium carbonate | 96. 300 |
| Magnesium carbonate | 3. 060 |
| Iron carbonate | 0. 053 |
| Matter insoluble in acids | 0. 630 |
| Organic matter | 0. 004 |
| Total | 100. 047 |

The stone weighs on an average 170 pounds to the cubic foot, although it sometimes reaches 180 pounds.

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[a] Special acknowledgments are due to Mr. M. H. Bancroft, of Swarthmore College, Pennsylvania, for valuable assistance in connection with Vermont statistics.

DESCRIPTION OF VERMONT QUARRIES.—Vermont marble is so well known the world over that it is scarcely necessary to say that the product of this state is well adapted to all the uses to which fine marble has been put. At the southern end of the marble belt in Vermont are the quarries of Messrs. D. L. Kent & Co., Freedley & Sons, the National Marble Company, and S. F. Prince & Co. These quarries are in the vicinity of Dorset mountain, and the stone produced is somewhat coarse in its crystallization, but quite sound. It has been used in the past to a considerable extent for building purposes, but the tendency now is to manufacture it into monumental products. Some of these quarries are between 6 and 7 miles from the railroad station, and the stone is hauled for that distance over a hilly road. 2 of these quarries, one belonging to Messrs. S. F. Prince & Co. and the other to Messrs. Freedley & Sons, are at a considerable altitude on the steep side of Dorset mountain. The one belonging to Messrs. Freedley & Sons, and the older of the two, is connected with the road by a double-track gravity system, so arranged that loaded cars going down draw the unloaded cars up. Mills for sawing are operated by all of the above-mentioned firms in this locality, but considerable stone is also sold in the rough without sawing, especially that used for heavy building work. Steam power is used in all cases except in the mill of Messrs. S. F. Prince & Co., which has a 28-inch turbine.

Passing northward from these quarries, the next locality of importance is West Rutland. Here the largest operators in the state are to be found. Some of the mills connected with the quarries at West Rutland are located at Rutland. This is the case with the Columbian Marble Company and the Vermont Marble Company. At West Rutland are the Sheldon, the Albertson, the True Blue, and the Orvillo quarries, in addition to those of the Vermont Marble Company. The Sheldon quarries comprise 4 openings: first, the Covered quarry; then 2 others, known by their numbers, "One" and "Two", and finally the North quarry. The most extensive of these is the Covered quarry. It is about 300 feet deep, the opening being about 200 by 250 feet, and extends at the bottom on the north and east sides in galleries 200 feet long. The marble taken from this opening is a mottled blue and white for most of the depth, but at the bottom a deposit of dark blue is found. Compressed air, instead of steam, is used in running the quarry machinery. The compressors are located in the engine room of the mills, and the air is carried in pipes from that point to machines in the quarry. 2 dynamos, of 45 and 15 horse power, respectively, are used in lighting the quarry, the office, and the mills. The marble taken from this quarry is exceptionally sound, and the blocks may be of any desired size, limited only by the capacity of the derricks. Quarries One and Two, just east of the Covered quarry, are not so deep as the latter, and have been opened at a more recent date. Steam is used in these quarries. The mills of this company, immediately adjacent to the quarries, are substantially built of blocks taken from the waste, and their equipment is very complete. 74 gangs of saws are operated. In addition to the mills there is a blacksmith shop, machine shop, finishing shop, and a carpenter shop. For finishing and polishing the work 2 buffers are employed, but most of the polishing is done by hand. A railroad siding, branching from the main road at West Rutland, runs through the yards and extends toward the northwest along the limestone belt, thus accommodating other quarries in addition to the Sheldon.

Immediately north of the Sheldon quarries are the openings of the Vermont Marble Company. The largest of these is nearest the Sheldon Covered quarry. It is known as the Gilson quarry, and is 250 or 300 feet deep. Adjoining this is the one known as the Old quarry. Next in order is the New quarry, then the Clement, and finally the Sherman. Several mills operated by this company are placed directly back of the above-named quarry openings, and they employ 37 gangs of saws and 3 rubbing beds. A large quantity of the stone quarried at this point is sawed at the mills of this company situated in Centre Rutland, where 64 gangs of saws and 3 rubbing beds are operated. The stone is of practically the same character as that in the Sheldon quarry.

The Albertson quarry is next in order, and is a comparatively new one. At the extreme end of the railroad siding above referred to is the True Blue marble quarry, which was opened during the past year. The surface rock has been removed, but operations have not proceeded far enough to secure any large quantity of marketable stone. A limekiln has been erected close to the mouth of the quarry, and a considerable portion of the product thus far yielded has been burned into lime. The lime produced can not be regarded as of the highest grade, as it is not perfectly white. It is, however, quite strong, and gives satisfaction in buildings. A mill containing 8 gangs of saws is operated in connection with this quarry. The Orvillo quarries, 3 miles south of West Rutland, have recently been opened, but the stone has not yet been placed on the market. Its quality, however, appears to be satisfactory. The next quarries in order are those of the Vermont Marble Company at Proctor.

Following the belt still farther toward the north, 2 quarries at Florence are met with. One of these is operated by the Wheaton Marble Company, the other by Messrs. Smith & Brainard. The stone of the Wheaton quarry is sold in the rough. The mills operated by Messrs. Smith & Brainard are located at Middlebury, and the quarry product is hauled to the railroad, about a mile and a half away. Some distance back of these quarries a new quarry has been started during the past year by the Venetian Marble Company, but the product has not been placed on the market. No mills have yet been built.

Farther north are the quarries at Brandon. This point may be regarded as the northern limit of the finest grade of marble. Within a radius of about 3 miles from the railroad station there are several quarries, those of the Brandon Italian Marble Company being the oldest at present operated. The stone is light, almost white in color, and is very finely crystallized. The Corona Marble Company has recently opened several shafts to the north of the Brandon Italian Marble Company, and 1 of these has proved very satisfactory. Operations are being rapidly pushed, and mills have been recently built. Some of the stone quarried here is of the very highest grade, suitable for statuary purposes. There is considerable lateral pressure on the stone in these quarries, which renders quarrying in some cases quite difficult. The finest stone does not run throughout the quarry, but lies below the more ordinary stock. Messrs. Davidson & Sons, with headquarters at New York city, have recently opened a quarry near that of the Corona Marble Company. No mills are operated at the quarry, but the product is shipped in rough blocks to the mills operated by the company at New York city and at Watertown, New York. A comparatively small quarry in this vicinity is operated by Mr. L. B. Peck, who sells the stone in the rough to other firms, who do the sawing and finishing. Quarries and mills are operated by the Bardillo Marble Company, 3 miles southwest of the station, to which it is necessary to haul the product by wagon. In crystalline condition and color most of the stone produced at Brandon is very fine.

Passing still farther north, there is little to be noticed until Swanton is reached. The product of this place goes under the name of Champlain marble. Its color varies from red to brown and drab, and its crystallization is somewhat coarse. Some of the product, especially that of Saint Albans bay, is dark green, and is known as verd antique. The Barney Marble Company, operating mills at Swanton, has several quarries in or near this place. The depth of these quarries is not great, and the stone is taken mainly from the surface. Owing to the hardness of the stone, the Knox system of blasting is employed, thus rendering channelers unnecessary, although steam drills are used in boring the holes required by this system of blasting.

By far the largest producing concern in the country is the Vermont Marble Company, with headquarters at Proctor. All the quarries operated by this firm are not, however, in this immediate vicinity. The 3 most important operated are the Sutherland Falls and Mountain Dark quarries, at Proctor, and the West Rutland quarries, located as their name indicates. The stone varies in color from white, rivaling the Carrara, in the West Rutland quarry, to a very dark-clouded blue in the Mountain Dark quarry. The color of the Sutherland Falls marble is intermediate between the shades of the other two, and presents a clouded or mottled appearance. The hardness of the stone is quite variable. Around the quarries and mills the company has built villages for the accommodation of its employés. A railroad 12 miles in length, equipped with the necessary rolling-stock and other appurtenances, is under the complete control of this company, and most of the quarry engines and machinery are built in shops owned and operated by it. Additions to the plant in the shape of buildings and mills, additional machinery, etc., are constantly being made. The power employed is largely hydraulic, amounting to 2,500 horse power, which is transmitted by the use of 75-horsepower air compressors, in which air is submitted to a pressure of 60 pounds to the square inch and carried in long lines of pipe to the various points of application. By the use of arc and incandescent lights, operated by 2 dynamos, work is carried on at night just as effectively as in daytime. Operations are practically continuous throughout the year, being interrupted only by excessive cold or snow in winter. Two-thirds of the output is converted into cemetery products and one-fourth into exterior building stock, while the remaining one-twelfth is devoted to interior decorative work in buildings. Blocks of any size that can be handled by derricks can be quarried. In the various Vermont mills operated by the firm 187 gangs of saws are in constant operation. In addition to the Vermont mills, there are others in different parts of the United States to which rough stock is shipped for finishing.

The Sutherland Falls quarry is also important. The stone is of fine quality, and is quarried with ease. Operations are conducted on an extended scale, and serve to illustrate the perfection which marble quarrying in the United States has attained. The mouth of this quarry is about 300 by 350 feet in area, and the opening has reached a depth of about 100 feet. 13 double Wardwell channelers, 2 single side-hill channelers, used for working at an angle, a diamond borer, 4 gadders, and 4 diamond drills are employed.

The Mountain Dark quarry, situated about a mile and a half north of the Sutherland Falls quarry, has been operated for a comparatively short time.

The mills at Proctor are the central works of the Vermont Marble Company and are furnished with every modern appliance for sawing and finishing the product. After the stone has been sawed it is sent to one of 3 finishing shops, according to the use to which it is finally to be put. In the shop devoted to monumental work there are 4 rubbing beds and 16 lathes, 6 of which are devoted to the polishing of smaller articles, such as monumental urns, etc., while in that for handling building stock is a heavy lathe capable of taking between its centers a block weighing 10 tons and turning a column 3 feet in diameter and 20 feet long. In the tile room, which is an adjunct to the building shop, are rubbing beds provided with special appliances for the rapid and accurate finishing of tiles. A vast amount of hard work is done in carving and decorating monuments and gravestones. A pneumatic tool for light carving is used in this mill.

Some of the uses to which Vermont marble is put are as follows: under the general head of monumental purposes are included statuary and decorated monuments, head and foot stones, markers, fence posts, ornamental railings and platforms, tombs, etc. The stone sold as building marble is used for decorative carving for exterior cornices, beltings, quoins, keystones, voussoirs, window and door caps, lintels, doorsteps, and facings, ashlar facings, and solid masonry in the walls. Interior work in buildings includes such items as tiling, wainscoting, mantels, chimney pieces, counters, paneling, etc., and furniture tops. Some quarries in the state are best adapted to one particular line of work, and in these cases stone is sold for only a limited number of purposes.

### TENNESSEE.

The total value of the marble produced in Tennessee for the year 1889 was $419,467. It comes mainly from Knox, Loudon, and Hawkins counties, although a small amount is produced in Hamblen, Blount, and Jefferson counties. The marble region is thus seen to be in the eastern part of the state, running in a northeasterly direction from Loudon county, at the south, to Hawkins county, at the northeast. The total value of the marble produced in 1880 was $173,600. The marble industry in this state is in a reasonably flourishing condition. The marble of Tennessee is in general easily quarried, and this fact has caused a number of property owners in the past to undertake quarrying operations on a small scale.

The methods of quarrying in this state are generally somewhat crude, and only a few channelers and other improvements in quarry machinery are in use.

Six marble-producing concerns have within a few years united, forming a combination known as the Tennessee Producers' Marble Company, the object of which is to maintain prices and carry on business more economically.

Tennessee marble presents much variety of color, and its great beauty is well known. It is especially well adapted for purposes of interior decoration in buildings and for furniture tops, but the amount devoted to the latter purpose is much less than it was a few years ago.

The processes of metamorphosis have in most of this marble stopped far short of the obliteration of fossil remains, the outlines of which are very plainly marked, and present a pleasing variety in the surface of the polished slab. The colors run from a very light pink through various shades to a chocolate brown and a mixed brown, white, and pink.

The product of Hawkins county is highly esteemed, and its price is almost twice that of the product of Knox or Loudon county. As shown by the numerous outcrops of marble in this state, it disintegrates rapidly under the influence of atmospheric agencies, but this does not detract from its adaptability for interior decoration, to which it is largely applied.

Some of the finishing mills in the state are well equipped and operated in a thoroughly modern way. The average cost per cubic foot of producing the marble output of Tennessee in 1889 was 85.1 cents. Of this amount 80.8 per cent was paid for labor involved in taking marble from the quarry and putting it into the shape in which it was sold. Cost of transportation by wagon and railroad from the quarry to the mill is in many cases quite a serious item of expense. The total number of individuals employed in this state is 749, including 27 boys under 16 years of age, but not including office force. The average amount per day received by each of these employés is $1.22. This is decidedly lower than the average for Vermont. The difference is accounted for by the lower price paid for labor in the south, and by the further fact that less intricate finishing work is done, since the product there is used largely for interior decoration, which requires much less detail than highly ornamented cemetery work in Vermont. So great is the difference in the purposes to which the marbles of Vermont and Tennessee are put that the industries in these 2 states can not be regarded as strictly in competition, an increase in demand for the product in one state producing comparatively little effect in a contrary direction upon the other.

Although the beginning of the marble industry in Tennessee dates back to the introduction of this stone for interior ornamental work in the national capitol at Washington, it must still be regarded as in its infancy. The chief obstacle to its rapid development has been the lack of transportation facilities. This obstacle is being overcome, and the introduction of more capital will undoubtedly produce results which have heretofore been only imagined.

### NEW YORK.

The total value of the marble produced in this state in 1889 was $354,197. The value of the marble reported at the Tenth Census was $224,500. The product is distributed among the following counties, arranged according to their output: Saint Lawrence, Westchester, Columbia, and Warren.

There are at present (1890) 5 quarries in operation in Saint Lawrence county, but only 3 were actually productive in 1889. The color of the Saint Lawrence county marble varies from white to dark blue and green and mixtures of these shades, producing in these cases a mottled appearance. The marble is adapted to monumental and building purposes, and the greater part of the product of 1889 was used for the latter purpose. This stone, while too coarsely crystalline for fine carving, scroll work, or tracing, forms a fine contrast with the polished surface. It weighs 174 pounds to the cubic foot, and has a crushing strength of 12,000 pounds to the inch. Preparations for increased production were quite active during 1889.

The quarries in Westchester county which were operated in 1889 are at Tuckahoe and Pleasantville. The product from Pleasantville is called, from its appearance, "snowflake marble", and is a dolomite, as is evident from the following analysis made at Columbia College:

ANALYSIS OF SNOWFLAKE MARBLE (DOLOMITE) FROM PLEASANTVILLE, NEW YORK.

| | PER CENT. |
|---|---|
| Calcium carbonate | 54.62 |
| Magnesium carbonate | 45.04 |
| Iron carbonate | 0.16 |
| Alumina | 0.07 |
| Silica | 0.10 |
| Total | 99.99 |

This marble is especially adapted for use in the preparation ot carbonic acid. Its weight per cubic foot is 130 pounds. The product of 1889 was mostly used for burning into lime and for the preparation of soda water. A small quantity was used for monumental cemetery work, but none for building purposes. The Tuckahoe marble was used for building, macadamizing roads, and for the preparation of soda water. Like the Pleasantville marble, it is a dolomite.

The product of Warren county, which comes from Glens Falls and its vicinity, consists of black marble, which is generally used for tiling and to some extent for other kinds of interior decoration, soda-water fountains, clock frames, etc. The stone is quite hard, and is quarried by light blasting, and some of it, owing to the looseness of the beds, can be removed by ordinary tools. The rougher stone is largely burned into lime.

At Hudson, in Columbia county, and at Catskill, across the river in Greene county, are quarries of what is known as "shell marble", largely made up of fossil remains. The stone is so irregular that quarrying is largely done by blasting. It is of a dull brownish color, and presents a beautiful appearance in finished surfaces, but owing to its character it can not receive the fine finish given to other more perfectly metamorphosed marbles.

The marble industry in this state gives employment to 395 men, not including office force. The average amount per day received by each of these employés is $1.82.

### GEORGIA.

No mention whatever of marble or limestone production in this state was made in the reports of the Tenth Census, and in fact the promising developments to be considered in the present report have in the main been made within the past 6 years, so that it now stands, according to value of output, in fourth place among the marble-producing states. As is evident from the table of production, the value of Georgia marble in 1889 was $196,250. This product comes from quarries in Pickens and Cherokee counties, in the northern part of the state, but by far the largest quantity comes from the first-named county.

Nearly all the output in Georgia is produced by the Georgia Marble Company, whose headquarters and quarries are at Tate, Pickens county. 5 quarries or openings, named, respectively, Creole No. 1, Creole No. 2, Cherokee, Etowah, and Kennesaw, are worked at present. The product of these quarries differs somewhat in color. The Kennesaw quarry yields a limited quantity of white marble, the crystals of which are large and glistening, but very compactly united, and in addition there is a white, clouded with light spots and lines of blue. The Cherokee quarry produces white and bluish-gray stock, both clouded with dark-blue spots. From the Creole quarries a marble having a white ground and exceedingly dark-blue mottlings is taken. This is used for monumental work and interior decoration. A great variety of different shades of marble is to be found in the Etowah quarry, the principal being pink, salmon, rose, and dark green. These with their combinations produce very rich effects, and are suitable for work in which high color and richness are desired. It finds its chief application in wainscoting, mantels, table tops, counters, panels, etc.

The following analysis was made by Mr. John C. Jackson, of Chicago:

ANALYSIS OF GEORGIA MARBLE.

| | PER CENT. |
|---|---|
| Calcium carbonate | 97.32 |
| Magnesium carbonate | 1.60 |
| Silica | 0.62 |
| Iron protoxide | 0.26 |
| Alumina | 0.25 |
| Total | 100.05 |

The following tests by compression of the strength of 3 cubes of Georgia marble, made in 1886 by Captain Marcus W. Lyon, United States army, with the testing machine at Watertown arsenal, Massachusetts, serve to indicate the great crushing strength of this marble:

MECHANICAL TESTS OF GEORGIA MARBLE.

| Test number. | MARKS. | DIMENSIONS. | | Sectional area. (Square inches.) | ULTIMATE STRENGTH. | |
|---|---|---|---|---|---|---|
| | | Height. | Compressed surface. | | Total pounds. | Pounds per square inch. |
| 4337 | Cherokee | 6''.04 | 6''.01 by 6''.00 | 36.06 | 395,800 | 10,976 |
| 4338 | Creole | 6''.03 | 6''.00 by 5''.99 | 36.94 | 434,100 | 12,078 |
| 4339 | Etowah | 6''.03 | 6''.03 by 6''.01 | 36.12 | 384,400 | 10,642 |

The structure of the marbles from the various quarries is essentially the same, the difference being in color only. The nonabsorbent properties are indicated by the following experiments, made by Professor J. B. Johnson, of Saint Louis, Missouri:

> A 3-inch cube was soaked in water 24 hours and weighed. It was then dried over a steam coil at a temperature of about 215° fahrenheit for 24 hours and again weighed. The difference in the weight divided by the weight when dry showed that it had absorbed water to an amount expressed by six-hundredths of 1 per cent. The nonabsorbent qualities thus revealed enable the stone to withstand disintegration.

The Georgia Marble Company has a very fine plant. The stone is not finished in final condition for anything but building purposes, but the mill at the quarries is well equipped with saws, rubbing beds, etc., and the electric-light plant enables work to be prosecuted at night. A railroad about 2 miles long, owned by the company, connects the quarries with the Marietta and North Georgia railroad, which forms an outlet for the product. The operations of this company have extended over a period of 6 years, but most of the work of developing has been done within the last 3 years. The company either owns in fee simple or controls in long leases over 7,000 acres of marble land.

3 miles from the quarries of the Georgia Marble Company are those of the Southern Marble Company, which has lately been organized. Operations of production are now fairly under way.

The American Marble Company, with quarries 2 miles west of Holly Springs, Cherokee county, and business headquarters at Marietta, is quarrying verd antique. This stone, although not marble, is used for interior decoration, etc., which brings it into immediate competition with marble, and statistics relating to it are therefore included.

### MARYLAND.

The value of the marble product in this state in 1889 was $139,816. According to the report of the Tenth Census it was $65,000 in 1880.

Included in the product of 1889 is the marble from quarries at Cockeysville, Baltimore county, and also "green serpentine" from quarries in Harford county. The latter stone is included with marble for the same reasons already given in connection with the production of verd antique in Georgia.

The following is an analysis of the stone made by Dr. F. A. Genth, of Philadelphia:

ANALYSIS OF SERPENTINE FROM HARFORD COUNTY, MARYLAND.

| | PER CENT. |
|---|---|
| Silica | 40.06 |
| Alumina | 1.37 |
| Chromic oxide | 0.20 |
| Nickel oxide | 0.71 |
| Ferrous oxide | 3.43 |
| Manganous oxide | 0.09 |
| Magnesia | 39.02 |
| Water | 12.10 |
| Magnetic iron | 3.02 |
| Total | 100.00 |

Serpentine is decidedly harder than marble, and has a specific gravity of 2.668. The color varies from a pale green to a blackish green, and is very beautiful. Operations of quarrying began in 1880.

The marble quarries at Cockeysville have been operated regularly for years. The product is used to some extent for cemetery work, and also largely for building purposes, particularly in Baltimore, where it enters into the construction of a number of the finest structures. It has also been used in Philadelphia and in the extension of the national capitol. The Beaver Dam Marble Company is the most important firm, and has a well-equipped plant, including the modern improvements for quarrying and sawing. The most practical test which has been made of the strength of this marble was its use as material for the Washington monument in the District of Columbia, the highest stone structure in the world.

### CALIFORNIA.

The value of the marble product in this state in 1889 was $87,030, which was taken from quarries in San Bernardino, Amador, Inyo, and San Luis Obispo counties, five-sixths of it coming from the first-named county. No figures of limestone or marble production are given in the report of the Tenth Census, as all the quarries in this state are new, and none of them can be regarded as more than fairly under way, although the outlook is unquestionably good. The product of San Bernardino county is used for monumental purposes and for building (both interior and exterior), tiling, and dimension stone. Preparations for increased future output in the way of additions to existing plants are actively going on. The product of Amador county is used principally for copings, and but little for monumental work.

The operations near Keeler, in Inyo county, date back only a few years, and are still in the initial stages of preparation. The stone is a dolomite, as is evident from the following analysis, made in the laboratory of the University of California:

ANALYSIS OF INYO COUNTY, CALIFORNIA, MARBLE.

| | PER CENT. |
|---|---|
| Carbonic acid | 47.353 |
| Iron | 0.017 |
| Calcium oxide | 31.042 |
| Magnesium oxide | 21.791 |
| Total | 100.203 |

This stone weighs 178.5 pounds to the cubic foot, and is extremely nonabsorptive. A mill for finishing and polishing is now in course of erection. Water power of 500 horse power is at hand. The product of San Luis Obispo county is the so-called "onyx", similar to Mexican onyx, and shows a great variety of colors—green, blue, golden, and mixtures of these colors. Heretofore the stone has been transported on horseback to the nearest shipping point, but recently a wagon road has been built, and this improvement is expected to have the effect of considerably increasing the output.

## VIRGINIA.

Within the past few years a marble quarry has been opened and worked at Mountsville, Loudoun county, by the Virginia Marble Company. Although considerable merchantable stone has been quarried, practically none has been sold, as it has been found impracticable to transport the product by wagons over the roads which connect the quarries with Leesburg, the nearest point on the railroad. There are prospects that a branch railroad connecting with the Chesapeake and Ohio may be built to the quarries, but until this is done the product can not be considered as on the market. The extent of operations so far consists of a surface opening measuring 100 by 80 feet and about 20 feet in depth, at which depth sound stock has been found. 2 floors, extending entirely over the above area, have been removed, but the third layer has been contracted in area to one-half of the original opening. 3 floors have been taken out over this contracted area, so that the greatest depth is 48 feet below the surface of the earth. The plant at the quarry consists of a number of channelers, a steam derrick for hoisting, and a gang of slab saws. The product shows a variety of colors, namely, white, creamy white, green, and green and white mixed in streaks and spots, the green shading into very dark green and chocolate. For interior decoration and for furniture tops it would undoubtedly be very handsome. The company owns 99 acres of land, all of which is believed to be quarry property.

## PENNSYLVANIA.

The entire product comes from Montgomery county, is taken from quarries near Conshohocken and King of Prussia, and is used largely for building purposes, chiefly for steps, window sills, exterior trimmings for houses, etc. The waste is used as flux in iron furnaces, and also in the manufacture of glass. These quarries have been operated for a number of years.

## MASSACHUSETTS.

The product of 1889 came from Lee, Berkshire county, in the western part of the state, nine-tenths of which was used for building purposes and the remainder for monumental work. This marble has long been known, and has entered into the construction of many fine buildings in various cities of the country. It is a dolomite, white in color and coarsely crystalline in texture.

## ALABAMA.

Marble has been found near Florence, Lauderdale county, only 1 mile distant from the Louisville and Nashville railroad. No product has been quarried, but some preliminary steps have been taken which may lead to productive operations in the near future.

## IDAHO.

At Spring Basin, Cassia county, marble is produced in sufficient quantities to supply local demand. It is suitable for cemetery work, but has never entered the market in competition with the well-known marbles of other regions.

## COLORADO.

A marble quarry has been opened at a point 14 miles north of Salida, Chaffee county. The stone is properly a dolomite, and is adapted to monumental work, statuary, furniture, and building purposes. The variety of color in this stone is very great, and the product appears to be of good quality. Developments, however, have hardly progressed far enough to justify definite statements. Marble quarries have been opened near Silver Cliff, in Custer county; at Livermore, in Larimer county; in the Elk mountains at the head of Rock creek, in Pitkin county, and at the head of Yule creek, in Gunnison county. There has been no production of marble except specimens, but the beds opened in the Elk mountains produce stone of such fine quality that it is probable the marble will enter the market on the completion of the railway now being built up Rock creek to these quarries. It is here found chiefly of a white color and fine texture, and seems well adapted to all the uses to which marble is ordinarily put. Deposits of different colors, similar in character to the white marble, have also been opened.

## METHODS OF QUARRYING.

The method of quarrying is essentially the same in most marble quarries. With fine marble, blasting seems to be entirely out of the question, because of injury to the stone, which has been amply proved by past experiments in Italy. This injury has not always been apparent in freshly quarried stone, but has been revealed years after by disintegration. It has already been stated that the marble at Swanton, Vermont, and at a few quarries in other states, is quarried by the Knox system of blasting; but the product is not used for purposes which would be injuriously affected by blasting, and, furthermore, the character of the stone in such cases admits of the application of this method. Experiments in blasting marble have also been recently tried in California, but the results have not yet been made public. A spot for opening a quarry is selected with the greatest care. If the surface indications are not sufficient to determine the quality of the underlying marble, it becomes necessary to drill a hole to a greater or less depth into the body of the stone. This is accomplished by means of an ordinary diamond drill for prospecting; that is, a hollow tool cutting a circle and leaving a core, which is taken out when a proper depth is reached. Lengths of 10 or 12 feet are thus frequently taken out without flaws. If the core presents satisfactory indications, the surface material is stripped by blasting, so as to make an opening for the quarry. Derricks are then placed in position, and channelers, drills, and gadders commence operating upon the comparatively level floor secured by the operations of stripping. A channeler then cuts 2 grooves or channels across the grain of the stone the width of the channeler apart (about 5 feet). The stone thus separated from the rest is called the key course. This is cut across at intervals to the same depth as the long channels, namely, the thickness of the bed operated upon. The key course is thus cut into blocks, which are held to the fixed marble only on the under side. To separate the blocks from the quarry two processes are in use. According to one of these, a block, called the "key block", is blasted out, destroying it, but also separating it at the bottom, thus giving space for operating upon the adjacent block to be taken out entire and in sound condition. Instead of blasting, the key block may be loosened at the bottom by means of wedges driven into the channels at one side and one end. A ring fastened into the center of the block forms a means of attachment to the derrick, which then lifts it from the floor. In the latter method more time is consumed, but the key block is saved. After the key block is removed, space sufficient for the introduction of the gadder is secured. The gadder, similar to the drill, bores horizontal holes 6 inches apart into the adjacent block at the bottom. Iron wedges, known as "gadding pins", are then driven into the holes, thus separating the block at the bottom. In order to avoid breaking a block at the edges the pins are a foot or more in length. When the key course has been removed several courses parallel to it are channeled out and removed in a similar manner. The channelers require 2 men, a runner and his helper, and will cut 75 channel feet per day to a depth of about 5 feet.

The drills operate by striking rapid blows, and the diamond borer cuts by revolving, the cutting edge consisting of diamonds set into the end. The underlying marble is cut into successive floors, as in the case described, thus gradually sinking below the surface, until, as in the Rutland and Proctor quarries, depths of 200 to 300 feet have been reached. Steam is commonly employed in running the quarry machinery, but in some cases compressed air is used and hoisting is done by derricks. The usual size of blocks taken out is 4 feet by 4 feet 6 inches by 6 feet 6 inches, but for special purposes considerably larger blocks are frequently removed.

## METHODS OF MANUFACTURING.

If the marble quarried as above is to be sold in sawed or in finished condition the blocks are transported to the mills, where they are sawed into slabs of various thicknesses. The saws consist of strips of steel fastened to an oscillating frame. The cutting material is sand, which, mixed with water, continually flows over the block and into the cuts made by the saws, and is fed upon the block either by hand or automatically. In the automatic process of feeding the sand is first delivered from a hopper into a well conveniently located in the mill, from which the mixture of water and sand is pumped through a main pipe connected with various branches which deliver the contents upon the blocks of stone.

After sawing, the blocks or slabs are placed upon a rubbing bed, consisting of a circular iron disk revolving horizontally and continually supplied with the same mixture of sand and water used in sawing. A rather smooth but dull surface is thus secured, and the stone is then ready for decorative work or for carving and polishing.

The polishing of large surfaces is accomplished by means of a buffer, which consists of a rapidly revolving wheel covered with flannel and charged with a so-called putty powder, and frequently with a mixture of putty and oxalic acid. This wheel is capable of a universal horizontal movement while revolving, so that it may reach all parts of the slab. Much of the polishing in Vermont mills is necessarily done by hand on account of the delicate nature of the work, owing to the intricacies of surface resulting from carving. In Tennessee mills, where large plain slabs for wainscoting and partitions are polished, the practice of machine polishing is much more general.

The light carving, or "skin work", as it is called, is largely done in the old-fashioned way, with mallet and hand cutting tool; but a recently patented pneumatic tool, delivering a large number of light blows per second, is now being introduced. This is held in the hand and moved along the outline to be cut into the stone. Its work is very rapid and it appears to be gaining in favor. It is used not only for the softer kinds of stone but also for granite.

In the preparation of stone for architectural designs, such as moldings, cornices, etc., planers similar to iron ones are used. Monumental urns and turned architectural work are produced by means of lathes, which are used both for cutting and polishing the various forms.

## WASTE AND ITS UTILIZATION.

The operations of quarrying and manufacturing marble are attended by a large amount of waste. This has been estimated by one authority to run as high as 25 per cent of the quarry output before the stone is ready for market, although it does not always run as high. This waste is due partly to natural defects in the rock as it lies in the quarry, but more particularly to the process of working the blocks into final shape. Sometimes the defects in a block of stone do not appear until sawed into slabs, and it may be that most of the block is on that account cast aside as waste. This difficulty is naturally met with only infrequently in the best quarries, and the original selection of these openings has been usually the outcome of sound judgment, coupled with geological knowledge and years of experience in marble quarrying. Financial disaster has very frequently followed unfortunate selections of points at which to open new quarries. The waste of quarries is utilized to some extent by the operator in the erection of mill buildings or to fill up excavations and natural hollows in the quarry or mill property, and some of it is used as railroad ballast and for the improvement of wagon roads. In one case limekilns have been built and the waste burned into lime, which, however, is not of the best grade. A small amount is sold for flux, and a small local demand for foundation stone is supplied at a low cost to purchasers. In the last 5 years a significant portion of the waste in Maryland quarries has been used with asphaltum in making paving block.

GENERAL STATISTICS OF MARBLE PRODUCTION IN 1889.

| STATES. | Total number of cubic feet produced. | Total value of product. | Total wages. | Total expenses. | Total capital. | PERCENTAGE OF PROFIT ON— |  | Per centage of wages to total expense. | Amount of wages paid per cubic foot. | Per centage of wages to total value. | Cost per cubic foot of product. | Value per cubic foot. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  | Capital. | Value of product. |  |  |  |  |  |
| Total | 3, 320, 213 | $3, 488, 170 | $1, 809, 211 | $2, 675, 069 | $15, 092, 842 | 5. 39 | 23. 31 | 67. 63 | $0. 545 | 51. 87 | $0. 806 | $1. 05 |
| California | 33, 792 | 87, 030 | 43, 615 | 72, 715 | 554, 000 | 2. 58 | 16. 45 | 59. 98 | 1. 291 | 50. 11 | 2. 152 | 2. 58 |
| Georgia | 250, 000 | 196, 250 | 76, 661 | 147, 086 | 2, 373, 627 | 2. 07 | 25. 05 | 52. 12 | 0. 307 | 39. 06 | 0. 588 | 0. 79 |
| Maryland | 333, 305 | 139, 816 | 78, 240 | 112, 504 | 576, 904 | 4. 73 | 19. 53 | 69. 54 | 0. 235 | 55. 96 | 0. 338 | 0. 42 |
| New York | 1, 171, 550 | 354, 197 | 182, 641 | 260, 804 | 1, 033, 461 | 9. 04 | 26. 37 | 70. 03 | 0. 156 | 51. 56 | 0. 223 | 0. 30 |
| Tennessee | 309, 709 | 419, 467 | 213, 214 | 263, 741 | 815, 500 | 19. 10 | 37. 12 | 80. 84 | 0. 688 | 50. 83 | 0. 852 | 1. 35 |
| Vermont | 1, 068, 305 | 2, 169, 560 | 1, 163, 973 | 1, 739, 988 | 9, 346, 928 | 4. 60 | 19. 80 | 66. 90 | 1. 090 | 53. 65 | 1. 629 | 2. 03 |
| Other states (*a*) | 153, 552 | 121, 850 | 50, 867 | 78, 231 | 392, 422 | 11. 12 | 35. 80 | 65. 02 | 0. 331 | 41. 75 | 0. 509 | 0. 79 |

*a* The states and territories here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Idaho, Massachusetts, Pennsylvania, Virginia, New Mexico, and Utah. In New Mexico and Utah there was preparatory work only, no product having been sold in 1889.

# LIMESTONE.

The production of limestone in the United States for the census year 1889 was as follows: for building purposes, 92,289,896 cubic feet, valued at $5,405,671; converted into lime, 18,474,668 barrels, valued at $8,217,015; stone for burning into lime, 478,082 tons, valued at $184,024; flux for furnaces, 3,894,337 tons, valued at $1,569,312; for street work, 46,491,622 cubic feet, valued at $2,383,456; for bridge, dam, and railroad work, 26,679,012 cubic feet, valued at $1,289,622; miscellaneous uses, 549,875 cubic feet, valued at $46,079; making a total value of $19,095,179. The expenditures were as follows: for wages, $10,121,985; for supplies and materials consumed, $4,227,246; other expenses of quarries, $743,483; making a total of $15,092,714. The capital invested in the industry amounted to $27,022,325; of this sum $14,771,200 was in land, $4,988,207 in buildings and fixtures, $4,541,623 in tools, implements, etc., and $2,721,295 in cash.

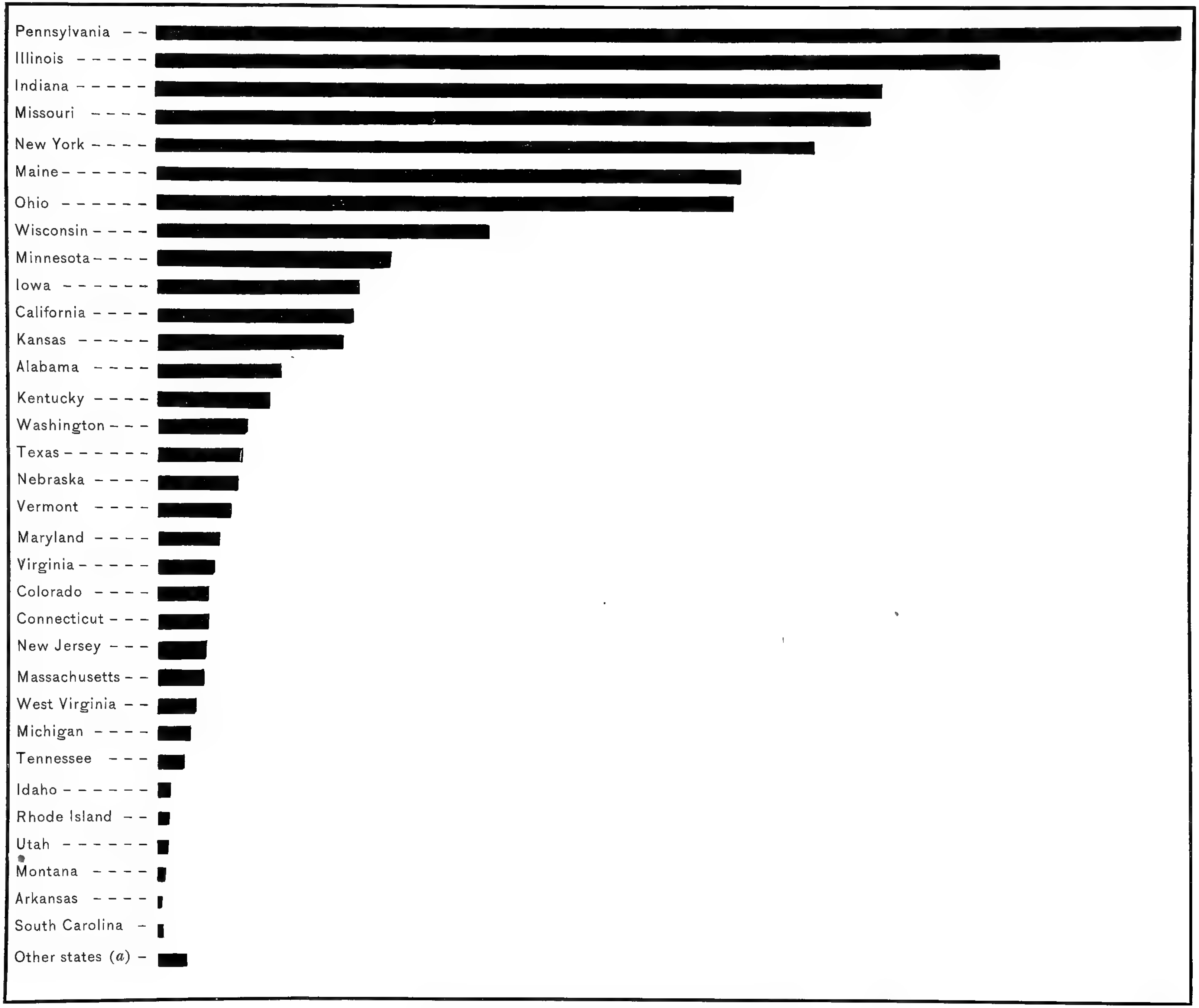
The name "limestone" carries with it the meaning "stone from which lime is made". Strictly speaking, therefore, it should apply only to the carbonate of calcium, which, by ignition, is converted into lime. The name, however, in practice covers quite a variety of materials which contain carbonate of calcium, but in very different degrees of purity. When limestone presents itself in crystalline condition, so as to be susceptible of fine polish and delicate ornamentation, it is known as marble. Marble is specially treated of in another report, inasmuch as its beauty of texture and fine crystalline condition make it applicable to uses for which the noncrystalline variety of limestone is entirely inadequate.

Calcium carbonate is frequently associated with magnesium carbonate in varying proportions. When the proportion of the latter is small the stone is called magnesian limestone, but when the proportion becomes 54.35 parts of calcium carbonate to 45.65 parts of magnesium carbonate it receives the name of "dolomite", which, if crystalline, may constitute a marble, but if noncrystalline is classed with the ordinary limestones. The term "ordinary limestone" is commonly used to include all the grades and degrees of limestone except marble, and "ordinary limestone" with this meaning is treated of in this report.

The limestones are mainly, though probably not entirely, of organic origin, resulting from the deposition and aggregation of shells, corals, etc.; but at the time of deposition other materials, such as clay, sand, iron oxides, iron pyrites, mica, etc., may have been included, thus producing a large number of grades, which are frequently distinguished by names which imply the presence of the most characteristic impurity. Siliceous, argillaceous, and micaceous limestones are names in common use. Usually the presence of these impurities is an objection to the stone for almost all the great variety of uses to which limestone is applied.

Among all the kinds of stone of commercial interest, limestone presents the widest range of variation in the qualities which are of special economic importance. Although it is essentially the carbonate of calcium, this compound may be so mixed with other materials as to be for practical purposes anything but limestone and, indeed, it would seem frequently unfortunate that the name limestone should have to do duty for a large number of materials which show vast differences in quality. The grouping of the various limestones under one general head is made necessary chiefly by the fact that no standard classification has been adopted among the producers, and distinctions clearly recognized in one locality are unknown in some other region, and especially is this the case among the smaller and more widely separated producers. It is the difficulty of securing any returns even of the simplest character from these small producers which limits the scope of a general investigation complete for the United States. A classification of the statistics according to the varieties of limestone is also impracticable from the act that neither the chemical nor physical differences suffice for such a division. There is frequently as great a difference between the utility and value of two pure limestones differing but slightly in composition, such as the high-priced oölitic stone and Maryland limestone used for lime burning, as between the pure limestones on the one hand and the magnesian limestone or siliceous limestones on the other. The establishment of such classifications by means other than the producers' returns did not come within the census limitations.

It will be evident from the above that the range of prices per cubic foot of the various limestones must vary between extraordinary limits. There are many purposes for which limestone is alone suitable and for these its price meets no competition from other stones. In its application to lime burning and furnace fluxing, limestone stands alone, and, as will be seen from the table of production, large quantities are devoted to these purposes. The maximum value given in this report is $3.33 per cubic foot for a very small product (150 cubic feet) of hard siliceous limestone used for polishing marble and for other abrasive purposes and is referred to again on page 640. In another case an unusually high value for a small quantity is due to the use of a limestone for a peculiar form of paint. In the larger uses for building the same great variation in price is also observed. The forms of limestone, as with other stones, which prove to be unusually enduring and which gives pleasing architectural effects command a price above the average. On the other hand the average value of a state's product is frequently greatly reduced by the quantity of stone used for road ballast and rubble at 4 cents per cubic foot or even less. It is of course also reduced by the local use of inferior building stone where nothing else is available.



RELATIVE RANK OF STATES PRODUCING LIMESTONE.

*a* Arizona, Florida, Georgia, New Mexico, Oregon, South Dakota, and Wyoming.

It should be carefully noted that, in stating the amount of lime given in this report, the figures are limited to that which is manufactured by the producers of the limestone used, and do not include lime produced by lime burners, who purchase the limestone from quarrymen and then burn it into lime. The figures given in the table of production, page 632, for the total value of the limestone product, namely $19,095,179, represent the value of the industry to the limestone quarrymen; that is, it is the aggregate value of the product sold by them, whether of the stone itself or of the products made by them from it. The aggregate value of $19,095,179 shows the limestone industry to be greater in point of value of output than that of any other kind of stone on which a separate report has been made. Limestone used for blast-furnace flux is to a large extent quarried by the operators of blast furnaces. Such operators as conduct regularly equipped quarries have reported the limestone so quarried and used by them, so that their figures are included in the totals herein given. (*a*)

## GEOGRAPHICAL DISTRIBUTION.

The following statement shows the value of the output produced in each of the geographical divisions. The North Atlantic division includes the states of Connecticut, Maine, Massachusetts, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont; the South Atlantic, Florida, Georgia, Maryland, South Carolina, Virginia, and West Virginia; the North Central, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, Ohio, South Dakota, and Wisconsin; the South Central, Alabama, Arkansas, Kentucky, Tennessee, and Texas, and the Western, Arizona, California, Colorado, Idaho, Montana, New Mexico, Oregon, Utah, Washington, and Wyoming.

| | |
|---|---|
| North Atlantic | $6, 491, 834 |
| South Atlantic | 464, 171 |
| North Central | 10, 185, 203 |
| South Central | 937, 351 |
| Western | 1, 016, 620 |
| Total | 19, 095, 179 |

From this it is evident that the North Central division is the most important for the production of limestone, $10,185,203 worth of the total $19,095,179 being produced from this division. The most productive states of the North Central division are Illinois, Indiana, Missouri, and Ohio, in the order named, 3 of these states producing more than $1,000,000 worth each, and Illinois more than $2,000,000 worth. In the North Atlantic division the most important states are Pennsylvania, New York, and Maine, in the order named, 2 of these states producing more than $1,500,000 worth each, while Pennsylvania produces more than $2,500,000 worth.

The table on pages 632–635 gives, among other items, the states producing limestone in the order of value of output for the year 1889. From this it appears that 40 states produced limestone in 1889, while 18 were productive of both marble and limestone at the Tenth Census. All of the states which produce marble, however, also yield limestone. Pennsylvania heads the list with an output valued at $2,655,477. There is a very striking difference in the production in Pennsylvania in the Tenth Census as compared with the value of its output for the Eleventh Census. Limestone and marble together were valued at $240,934 at the former census, which is evidently a very small figure as compared with the value of the output at the present census. Comparisons, however, of the limestone production of the 2 censuses are almost impracticable, from the fact that ordinary limestone and marble were included in one statement at the Tenth Census, whereas in the present census they are separated. The total value of all limestone produced is $19,095,179, exclusive, of course, of marble, which, as will be seen in the report on marble, amounts to $3,488,170, so that the value of ordinary limestone and marble together would amount to $22,583,349. The combined value of the 2 kinds of stone for the Tenth Census was $6,856,681; in other words, the value in 1889 is between 3 and 4 times as large as that of 1880 for ordinary limestone and marble together.

The table of production following shows that $19,095,179 worth of ordinary limestone was produced from 1,954 quarries by a force of 30,644 men, including office force, to whom a total of $10,121,985 was paid in wages. The total expense of producing the limestone amounted to $15,092,714, thus indicating a profit to the producers of $4,002,465. The capital invested amounts to $27,022,325, of which amount $14,771,200 is invested in land.

Glancing at the purposes for which the stone is used, it appears that the value of the lime produced, namely, $8,217,015, is the greatest. The value of the limestone itself from which this lime was made is estimated at $1,477,974. It is important to remember in this connection that this lime was produced by the quarry operators who burned their own stone into lime, while that produced by lime burners purchasing the stone is not included here.

The item next in importance to lime in point of value is the stone used for building purposes, valued at $5,405,671. Next follows the value of stone used for flux in furnaces, namely, $1,569,312. For bridge, dam, and railroad work the amount is $1,289,622, and small values are given for stone sold for burning into lime, also for stone used for miscellaneous purposes. In point of value the limestone industry is ahead of all other stone interests, granite standing second.

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[a] In addition to the limestone quarried for blast-furnace flux, included in this report as coming from regularly operated quarries, there is a considerable amount produced by blast-furnace operators of which no complete account is kept, and consequently no statistics of such operations are given. The total value, however, of limestone used as flux is estimated at $3,500,000.

## PRODUCTION OF LIMESTONE IN 1889, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | Number of quarries. | Total value. | BUILDING PURPOSES. | | | LIME. | | | STONE FOR BURNING INTO LIME. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cubic feet. | Value. | Value per cubic foot. | Barrels. (200 pounds.) | Value. | Value per barrel. | Tons. (2,000 pounds.) | Value. | Value per ton. |
| Total | 1, 954 | $19, 095, 179 | 92, 289, 896 | $5, 405, 671 | $0. 06 | 18, 474, 668 | $8, 217, 015 | $0. 44 | 478, 082 | $184, 024 | $0. 38 |
| Alabama | 21 | 324, 814 | 154, 480 | 37, 981 | 0. 25 | 350, 340 | 178, 248 | 0. 51 | 12, 000 | 6, 024 | 0. 50 |
| Arkansas | 7 | 18, 360 | 9, 100 | 1, 260 | 0. 14 | 37, 600 | 14, 600 | 0. 39 | | | |
| California | 22 | 516, 780 | 12, 500 | 360 | 0. 03 | 533, 123 | 513, 130 | 0. 96 | | | |
| Colorado | 15 | 138, 091 | 56, 250 | 7, 300 | 0. 13 | 146, 737 | 91, 101 | 0. 62 | 15, 000 | 3, 750 | 0. 25 |
| Connecticut | 9 | 131, 697 | 33, 750 | 894 | 0. 03 | 191, 795 | 129, 663 | 0. 68 | | | |
| Idaho | 3 | 28, 545 | | | | 29, 871 | 28, 545 | 0. 96 | | | |
| Illinois | 104 | 2, 190, 607 | 21, 433, 967 | 1, 084, 556 | 0. 05 | 877, 274 | 366, 245 | 0. 42 | | | |
| Indiana | 172 | 1, 889, 336 | 7, 402, 345 | 994, 313 | 0. 13 | 1, 074, 517 | 340, 315 | 0. 32 | | | |
| Iowa | 143 | 530, 863 | 6, 280, 787 | 236, 792 | 0. 04 | 365, 394 | 170, 043 | 0. 47 | | | |
| Kansas | 115 | 478, 822 | 4, 562, 049 | 269, 316 | 0. 06 | 16, 686 | 9, 013 | 0. 54 | | | |
| Kentucky | 54 | 303, 314 | 1, 854, 917 | 187, 570 | 0. 10 | 66, 376 | 24, 414 | 0. 37 | | | |
| Maine | 60 | 1, 523, 499 | | | | 1, 903, 639 | 1, 523, 499 | 0. 80 | | | |
| Maryland | 30 | 164, 860 | 41, 807 | 1, 140 | 0. 03 | 545, 591 | 148, 432 | 0. 27 | | | |
| Massachusetts | 12 | 119, 978 | 283, 100 | 21, 833 | 0. 08 | 82, 977 | 93, 702 | 1. 13 | | | |
| Michigan | 8 | 85, 952 | 1, 296, 539 | 46, 308 | 0. 04 | 44, 173 | 15, 500 | 0. 35 | 13, 466 | 3, 313 | 0. 25 |
| Minnesota | 72 | 613, 247 | 7, 277, 348 | 380, 556 | 0. 05 | 344, 102 | 124, 266 | 0. 36 | 400 | 200 | 0. 50 |
| Missouri | 123 | 1, 859, 960 | 11, 083, 370 | 542, 871 | 0. 05 | 1, 144, 962 | 465, 390 | 0. 41 | | | |
| Montana | 4 | 24, 964 | 160, 000 | 7, 500 | 0. 05 | 2, 217 | 1, 464 | 0. 66 | | | |
| Nebraska | 29 | 207, 019 | 2, 058, 614 | 90, 542 | 0. 04 | 41, 805 | 16, 722 | 0. 40 | | | |
| New Jersey | 33 | 129, 662 | 28, 058 | 636 | 0. 02 | 400, 249 | 99, 406 | 0. 25 | | | |
| New Mexico | 4 | 3, 862 | 49, 675 | 1, 211 | 0. 02 | 2, 850 | 2, 331 | 0. 82 | | | |
| New York | 157 | 1, 708, 830 | 7, 154, 747 | 444, 291 | 0. 06 | 1, 636, 148 | 837, 613 | 0. 51 | 43, 003 | 21, 349 | 0. 50 |
| Ohio | 221 | 1, 514, 934 | 9, 754, 989 | 407, 388 | 0. 04 | 1, 725, 336 | 581, 325 | 0. 34 | 220, 095 | 98, 059 | 0. 45 |
| Pennsylvania | 373 | 2, 655, 477 | 5, 188, 013 | 238, 431 | 0. 05 | 4, 043, 679 | 1, 195, 955 | 0. 30 | 137, 285 | 37, 120 | 0. 27 |
| Rhode Island | 2 | 27, 625 | | | | 32, 100 | 27, 500 | 0. 86 | | | |
| South Carolina | 2 | 14, 520 | | | | 13, 500 | 6, 120 | 0. 45 | | | |
| Tennessee | 11 | 73, 028 | 11, 510 | 1, 336 | 0. 12 | 113, 228 | 60, 625 | 0. 54 | | | |
| Texas | 18 | 217, 835 | 666, 160 | 135, 901 | 0. 20 | 12, 000 | 6, 700 | 0. 56 | | | |
| Utah | 2 | 27, 568 | 120, 865 | 2, 600 | 0. 02 | 16, 480 | 10, 300 | 0. 63 | | | |
| Vermont | 16 | 195, 066 | 95, 040 | 5, 010 | 0. 05 | 324, 148 | 168, 808 | 0. 52 | | | |
| Virginia | 11 | 159, 023 | 471, 505 | 19, 520 | 0. 04 | 178, 480 | 83, 667 | 0. 47 | 15, 000 | 7, 500 | 0. 50 |
| Washington | 8 | 231, 287 | 15, 970 | 1, 580 | 0. 10 | 222, 759 | 224, 707 | 1. 01 | | | |
| West Virginia | 8 | 93, 856 | 194, 250 | 3, 835 | 0. 02 | 296, 498 | 82, 471 | 0. 28 | | | |
| Wisconsin | 79 | 813, 963 | 4, 537, 351 | 232, 780 | 0. 05 | 1, 561, 611 | 514, 974 | 0. 33 | 21, 833 | 6, 709 | 0. 31 |
| Other states (*a*) | 6 | 77, 935 | 840 | 60 | 0. 07 | 96, 423 | 60, 221 | 0. 62 | | | |

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*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Arizona, Florida, Georgia, Oregon, South Dakota, and Wyoming.

## PRODUCTION OF LIMESTONE IN 1889, BY STATES AND TERRITORIES—Continued.

| STATES AND TERRITORIES. | FLUX FOR FURNACES. | | | STREET WORK. | | | BRIDGE, DAM, AND RAILROAD WORK. | | | MISCELLANEOUS. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tons. (2,000 pounds.) | Value. | Value per ton. | Cubic feet. | Value. | Value per cubic foot. | Cubic feet. | Value. | Value per cubic foot. | Cubic feet. | Value. | Value per cubic foot. |
| Total | 3, 894, 337 | $1, 569, 312 | $0. 40 | 46, 491, 622 | $2, 383, 456 | $0. 05 | 26, 679, 012 | $1, 289, 622 | $0. 05 | 549, 875 | $46, 079 | $0. 08 |
| Alabama | 247, 761 | 92, 761 | 0. 37 | 98, 000 | 9, 800 | 0. 10 | | | | | | |
| Arkansas | | | | 2, 000 | 500 | 0. 25 | 32, 500 | 650 | 0. 02 | 13, 500 | 1, 350 | 0. 10 |
| California | | | | 35, 000 | 1, 390 | 0. 04 | | | | 31, 250 | 1, 900 | 0. 06 |
| Colorado | 51, 851 | 35, 940 | 0. 69 | | | | | | | | | |
| Connecticut | 3, 468 | 1, 140 | 0. 33 | | | | | | | | | |
| Idaho | | | | | | | | | | | | |
| Illinois | 300, 182 | 166, 507 | 0. 55 | 10, 221, 392 | 505, 576 | 0. 05 | 969, 899 | 65, 762 | 0. 07 | 13, 211 | 1, 961 | 0. 15 |
| Indiana | 2, 640 | 1, 056 | 0. 40 | 2, 614, 862 | 316, 722 | 0. 12 | 1, 410, 285 | 233, 710 | 0. 17 | 31, 400 | 3, 220 | 0. 10 |
| Iowa | | | | 1, 707, 931 | 53, 641 | 0. 03 | 1, 732, 630 | 70, 387 | 0. 04 | | | |
| Kansas | | | | 771, 041 | 97, 502 | 0. 13 | 2, 532, 801 | 102, 991 | 0. 04 | | | |
| Kentucky | 3, 244 | 1, 598 | 0. 49 | 1, 762, 711 | 86, 054 | 0. 05 | 14, 715 | 3, 178 | 0. 22 | 150 | 500 | 3. 33 |
| Maine | | | | | | | | | | | | |
| Maryland | 10, 080 | 6, 750 | 0. 67 | 145, 670 | 6, 750 | 0. 05 | 43, 680 | 1, 788 | 0. 04 | | | |
| Massachusetts | 4, 309 | 2, 443 | 0. 57 | | | | | | | 50, 000 | 2, 000 | 0. 04 |
| Michigan | 10, 957 | 2, 675 | 0. 24 | 485, 377 | 18, 156 | 0. 04 | | | | | | |
| Minnesota | | | | 68, 788 | 11, 778 | 0. 17 | 868, 144 | 90, 017 | 0. 10 | 87, 300 | 6, 430 | 0. 07 |
| Missouri | 13, 488 | 5, 691 | 0. 42 | 11, 542, 723 | 670, 351 | 0. 06 | 5, 471, 386 | 169, 720 | 0. 03 | 29, 688 | 5, 937 | 0. 20 |
| Montana | 17, 000 | 16, 000 | 0. 94 | | | | | | | | | |
| Nebraska | 21, 600 | 10, 000 | 0. 46 | 1, 926, 469 | 86, 643 | 0. 04 | 10, 000 | 2, 500 | 0. 25 | 56, 500 | 612 | 0. 01 |
| New Jersey | 59, 275 | 29, 620 | 0. 50 | | | | | | | | | |
| New Mexico | 400 | 320 | 0. 80 | | | | | | | | | |
| New York | 84, 222 | 32, 750 | 0. 39 | 5, 241, 262 | 197, 091 | 0. 04 | 1, 434, 115 | 175, 736 | 0. 12 | | | |
| Ohio | 280, 626 | 105, 963 | 0. 38 | 7, 236, 981 | 183, 235 | 0. 03 | 4, 984, 581 | 124, 518 | 0. 02 | 173, 788 | 14, 446 | 0. 08 |
| Pennsylvania | 2, 583, 926 | 949, 083 | 0. 37 | 2, 042, 804 | 72, 512 | 0. 04 | 3, 714, 444 | 155, 653 | 0. 04 | 60, 688 | 6, 723 | 0. 11 |
| Rhode Island | 50 | 125 | 2. 50 | | | | | | | | | |
| South Carolina | | | | | | | 56, 700 | 8, 400 | 0. 15 | | | |
| Tennessee | 5, 000 | 2, 800 | 0. 56 | 14, 500 | 3, 400 | 0. 23 | 115, 182 | 4, 867 | 0. 04 | | | |
| Texas | 16, 455 | 12, 037 | 0. 73 | 67, 750 | 32, 278 | 0. 48 | 638, 921 | 30, 919 | 0. 05 | | | |
| Utah | 32, 596 | 14, 668 | 0. 45 | | | | | | | | | |
| Vermont | | | | 9, 990 | 2, 098 | 0. 21 | 445, 500 | 18, 150 | 0. 04 | 2, 400 | 1, 000 | 0. 42 |
| Virginia | 78, 756 | 48, 146 | 0. 61 | 7, 560 | 190 | 0. 03 | | | | | | |
| Washington | 7, 000 | 5, 000 | 0. 71 | | | | | | | | | |
| West Virginia | 21, 600 | 7, 200 | 0. 33 | | | | 25, 000 | 350 | 0. 01 | | | |
| Wisconsin | 21, 564 | 8, 641 | 0. 40 | 488, 811 | 27, 789 | 0. 06 | 2, 048, 954 | 23, 070 | 0. 01 | | | |
| Other states (*a*) | 16, 287 | 10, 398 | 0. 64 | | | | 129, 575 | 7, 256 | 0. 06 | | | |

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*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Arizona, Florida, Georgia, Oregon, South Dakota, and Wyoming.

## PRODUCTION OF LIMESTONE IN 1889, BY STATES AND TERRITORIES—Continued.

| STATES AND TERRITORIES. | LABOR. | | | | | | | POWER. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total number of employés. | Foremen. | Quarrymen. | Mechanics. | Laborers. | Boys under 16 years. | Office force. | Number of boilers. | Total horse power. | Number of animals employed. | Horse power of water wheels. |
| Total | 30, 644 | 1, 470 | 16, 420 | 2, 037 | 9, 825 | 459 | 433 | 926 | 21, 945 | 6, 982 | 417 |
| Alabama | 837 | 23 | 209 | 26 | 534 | 31 | 14 | 23 | 772 | 207 | |
| Arkansas | 50 | 6 | 26 | 6 | 8 | 4 | | | | 13 | 10 |
| California | 302 | 21 | 89 | 16 | 170 | 1 | 5 | | | 166 | |
| Colorado | 114 | 12 | 50 | 26 | 24 | | 2 | | | 44 | |
| Connecticut | 95 | 5 | 38 | 23 | 27 | | 2 | 5 | 73 | 30 | |
| Idaho | 26 | 3 | 20 | 1 | 2 | | | | | 9 | |
| Illinois | 3, 240 | 125 | 2, 081 | 151 | 808 | 23 | 52 | 109 | 2, 939 | 606 | 94 |
| Indiana | 3, 383 | 162 | 1, 375 | 238 | 1, 440 | 99 | 69 | 167 | 3, 533 | 349 | |
| Iowa | 1, 254 | 70 | 692 | 78 | 371 | 25 | 18 | 29 | 662 | 261 | |
| Kansas | 1, 201 | 54 | 801 | 87 | 223 | 18 | 18 | 13 | 240 | 369 | |
| Kentucky | 777 | 46 | 423 | 59 | 219 | 23 | 7 | 28 | 798 | 245 | |
| Maine | 1, 063 | 131 | 607 | 50 | 260 | | 15 | 25 | 750 | 10 | |
| Maryland | 286 | 13 | 123 | 17 | 122 | 10 | 1 | 13 | 345 | 96 | |
| Massachusetts | 103 | 9 | 66 | 4 | 24 | | | 2 | 52 | 37 | |
| Michigan | 145 | 6 | 58 | 8 | 73 | | | 8 | 316 | 34 | |
| Minnesota | 1, 232 | 68 | 864 | 94 | 190 | 5 | 11 | 33 | 847 | 128 | |
| Missouri | 3, 220 | 133 | 1, 387 | 202 | 1, 422 | 36 | 40 | 77 | 1, 963 | 1, 212 | |
| Montana | 48 | 6 | 14 | 1 | 26 | | 1 | 1 | 45 | 20 | |
| Nebraska | 506 | 20 | 272 | 23 | 177 | 4 | 10 | 9 | 375 | 158 | |
| New Jersey | 230 | 11 | 158 | 8 | 48 | 2 | 3 | 2 | 45 | 64 | |
| New Mexico | 18 | 1 | 8 | 2 | 7 | | | | | 7 | |
| New York | 2,600 | 123 | 1, 052 | 323 | 1, 023 | 50 | 29 | 76 | 1, 666 | 542 | 293 |
| Ohio | 2, 626 | 145 | 1, 490 | 161 | 737 | 46 | 47 | 108 | 2, 767 | 735 | |
| Pennsylvania | 4, 832 | 166 | 3, 270 | 191 | 1, 094 | 54 | 57 | 123 | 2, 431 | 1, 003 | |
| Rhode Island | 31 | 2 | 14 | 3 | 10 | | 2 | 2 | 37 | 16 | |
| South Carolina | 46 | 2 | 18 | 1 | 24 | 1 | | 1 | 6 | 26 | |
| Tennessee | 163 | 6 | 75 | 10 | 71 | | 1 | 2 | 30 | 22 | |
| Texas | 278 | 12 | 154 | 26 | 81 | 3 | 2 | 6 | 48 | 74 | |
| Utah | 26 | 2 | 6 | 1 | 15 | 1 | 1 | | | 10 | |
| Vermont | 170 | 12 | 79 | 26 | 49 | 3 | 1 | 5 | 65 | 40 | 20 |
| Virginia | 253 | 10 | 63 | 24 | 141 | 7 | 8 | 3 | 80 | 47 | |
| Washington | 205 | 12 | 48 | 54 | 86 | 3 | 2 | 2 | 120 | 28 | |
| West Virginia | 126 | 7 | 58 | 18 | 41 | | 2 | 7 | 62 | 28 | |
| Wisconsin | 1, 048 | 42 | 637 | 77 | 270 | 9 | 13 | 45 | 853 | 317 | |
| Other states (*a*) | 110 | 4 | 95 | 2 | 8 | 1 | | 2 | 25 | 29 | |

*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Arizona, Florida, Georgia, Oregon, South Dakota, and Wyoming.

## PRODUCTION OF LIMESTONE IN 1889, BY STATES AND TERRITORIES—Continued.

| STATES AND TERRITORIES. | EXPENSES. | | | | CAPITAL. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total expenses. | Wages. | Supplies and materials consumed. | Other expenses of quarries. | Total capital. | Land. | Buildings and fixtures. | Tools, implements, etc. | Cash. |
| Total | $15,092,714 | $10,121,985 | $4,227,246 | $743,483 | $27,022,325 | $14,771,200 | $4,988,207 | $4,541,623 | $2,721,295 |
| Alabama | 259,118 | 199,480 | 47,980 | 11,658 | 353,071 | 124,500 | 112,900 | 92,371 | 23,300 |
| Arkansas | 14,440 | 9,850 | 4,023 | 567 | 32,531 | 27,650 | 1,600 | 2,775 | 506 |
| California | 354,930 | 164,615 | 175,840 | 14,475 | 857,409 | 525,515 | 193,250 | 103,644 | 35,000 |
| Colorado | 94,064 | 73,960 | 18,091 | 2,013 | 183,370 | 107.450 | 34,850 | 11,620 | 29,450 |
| Connecticut | 108,048 | 43,186 | 60,382 | 4,480 | 100,465 | 37,650 | 26,659 | 14,720 | 21,436 |
| Idaho | 17,301 | 11,159 | 5,532 | 610 | 27.200 | 14,700 | 6,000 | 1,300 | 5,200 |
| Illinois | 1,707,938 | 1,247,097 | 376,687 | 84,154 | 3,316,616 | 1,998,575 | 506,414 | 605,777 | 205,850 |
| Indiana | 1,423,504 | 1,025,689 | 333,625 | 64,190 | 3,170,385 | 1,478,190 | 463,230 | 672,310 | 556,155 |
| Iowa | 432,465 | 329,442 | 81,210 | 21,813 | 1,008,992 | 489,915 | 199,100 | 206,205 | 113,772 |
| Kansas | 364,049 | 317,480 | 35,696 | 10,873 | 734,301 | 528,313 | 54,332 | 96,903 | 54,753 |
| Kentucky | 240,744 | 194,092 | 29,763 | 16,889 | 510,189 | 260,087 | 31,405 | 176,083 | 42,614 |
| Maine | 1,474,890 | 679,825 | 754,845 | 40,220 | 1,120,500 | 514,200 | 349,200 | 68,100 | 189,000 |
| Maryland | 138,703 | 69,980 | 60,064 | 8,659 | 418,168 | 262,745 | 69,550 | 53,215 | 32,658 |
| Massachusetts | 95,831 | 47,431 | 46,732 | 1,668 | 72,451 | 30,350 | 14,750 | 14,081 | 13,270 |
| Michigan | 58,132 | 44,211 | 13,191 | 730 | 184,318 | 123,700 | 41,652 | 9,880 | 9,086 |
| Minnesota | 497,498 | 367,321 | 102,840 | 27,337 | 1,186,847 | 628,440 | 263,914 | 158,661 | 135,832 |
| Missouri | 1,523,257 | 1,181,115 | 281,565 | 60,577 | 2,066,017 | 1,053,102 | 339,622 | 433,531 | 239,762 |
| Montana | 20,350 | 16,375 | 3,800 | 175 | 39,500 | 21,000 | 7,900 | 10,600 | .............. |
| Nebraska | 164,533 | 129,906 | 24,390 | 10,237 | 268,710 | 131,000 | 17,935 | 80,550 | 39,225 |
| New Jersey | 109,492 | 62,926 | 40,588 | 5,978 | 152,539 | 84,797 | 37,497 | 21,795 | 8,450 |
| New Mexico | 3,019 | 1,754 | 1,195 | 70 | 19,600 | 11,800 | 5,250 | 1.500 | 1,050 |
| New York | 1,268,151 | 846,623 | 337,995 | 83,533 | 2,664,847 | 1,612.160 | 380,224 | 379,168 | 293,295 |
| Ohio | 1,138,070 | 797,082 | 280,247 | 60,741 | 2,283,986 | 1,311.130 | 478,557 | 300,833 | 193,466 |
| Pennsylvania | 2,178,013 | 1,421,496 | 620,279 | 136,238 | 3,402,345 | 1,799,915 | 730,040 | 633,358 | 239,032 |
| Rhode Island | 22,440 | 9,992 | 12,140 | 308 | 37,400 | 25,000 | 9,000 | 3,400 | .............. |
| South Carolina | 11,440 | 8,555 | 1,835 | 1,050 | 14,250 | 7,000 | 2,100 | 4,050 | 1,100 |
| Tennessee | 51,487 | 38,040 | 12,190 | 1,257 | 79,915 | 32,890 | 37,850 | 7,775 | 1,400 |
| Texas | 114,022 | 96,778 | 13,678 | 3,566 | 69,705 | 37,355 | 9,050 | 21,500 | 1,800 |
| Utah | 19,577 | 13,172 | 5,405 | 1,000 | 155,225 | 145,000 | 7,550 | 2,675 | .............. |
| Vermont | 141,660 | 55,959 | 79,199 | 6,502 | 160,424 | 64,250 | 45,450 | 31,539 | 19,185 |
| Virginia | 116,636 | 80,994 | 32,831 | 2,811 | 99,875 | 47,300 | 29,500 | 17,300 | 5,775 |
| Washington | 211,418 | 133,215 | 67,595 | 10,608 | 584,825 | 333,320 | 179,680 | 58,325 | 13,500 |
| West Virginia | 51,323 | 28,651 | 21,002 | 1,670 | 217,188 | 120,058 | 25,261 | 35,869 | 36,000 |
| Wisconsin | 617,911 | 345,184 | 226,925 | 45,802 | 1,397,986 | 770,143 | 262,785 | 205,285 | 159,773 |
| Other states (*a*) | 48,260 | 29,350 | 17,886 | 1,024 | 31,175 | 12,000 | 14,150 | 4,425 | 600 |

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*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Arizona, Florida, Georgia, Oregon, South Dakota, and Wyoming.

The following table gives statistics of labor and wages for all states producing ordinary limestone. It will be noticed that the highest wages are those paid in the western states, and the lowest are those for the southern states.

It will also be noticed that the total wages reported in the table on page 635 as actually paid do not exactly agree with the figures which would result from computing the total wages from the data given in the following table. This is very naturally the case, since the figures of the latter table are the averages given by the producers in response to an inquiry calling for average statements. The figures given for total wages actually paid are exact.

LABOR AND WAGES CLASSIFIED, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | FOREMEN. | | | | QUARRYMEN. | | | | MECHANICS AND STONECUTTERS. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number. | Average daily wages. | Average number of days. | Average yearly earnings. | Average number. | Average daily wages | Average number of days. | Average yearly earnings. | Average number. | Average daily wages. | Average number of days. | Average yearly earnings. |
| Alabama | 23 | $2.24 | 257 | $575.68 | 209 | $1.17 | 202 | $236 34 | 26 | $2.09 | 181 | $378.29 |
| Arkansas | 6 | 1.62 | 175 | 283.50 | 20 | 1.34 | 127 | 170.18 | 6 | 1.26 | 195 | 245.70 |
| California | 21 | 3.47 | 255 | 884.85 | 89 | 2.18 | 228 | 497 04 | 16 | 2.31 | 253 | 584.43 |
| Colorado | 12 | 2.78 | 231 | 642.18 | 50 | 2.33 | 271 | 631.43 | 26 | 2.71 | 150 | 406.50 |
| Connecticut | 5 | 1.90 | 306 | 581.40 | 38 | 1.58 | 250 | 395.00 | 23 | 1.84 | 280 | 515.20 |
| Idaho | 3 | 3.48 | 192 | 668.16 | 20 | 2.09 | 201 | 420 09 | 1 | 2.00 | 90 | 180.00 |
| Illinois | 125 | 2.55 | 259 | 660.45 | 2,081 | 1.64 | 210 | 344 40 | 151 | 2.35 | 230 | 540.50 |
| Indiana | 162 | 2.48 | 208 | 515.84 | 1,375 | 1.59 | 198 | 314.82 | 238 | 2 33 | 178 | 414.74 |
| Iowa | 70 | 2.01 | 197 | 395.97 | 692 | 1.53 | 175 | 267 75 | 78 | 2.48 | 180 | 446.40 |
| Kansas | 54 | 2.63 | 190 | 499.70 | 801 | 1.56 | 175 | 273.00 | 87 | 2.70 | 173 | 467.10 |
| Kentucky | 46 | 2.40 | 225 | 540.00 | 423 | 1.39 | 167 | 232.13 | 59 | 2.21 | 172 | 380 12 |
| Maine | 131 | 2.30 | 287 | 660.10 | 607 | 2.00 | 280 | 560.00 | 50 | 2.00 | 250 | 500.00 |
| Maryland | 13 | 1.65 | 235 | 387.75 | 123 | 1.29 | 182 | 234.78 | 17 | 1.52 | 173 | 262.96 |
| Massachusetts | 9 | 1.98 | 243 | 481.14 | 66 | 1.50 | 257 | 385.50 | 4 | 3.19 | 121 | 385.99 |
| Michigan | 6 | 2.67 | 281 | 750.27 | 58 | 1.53 | 201 | 307.53 | 8 | 1.74 | 293 | 509.82 |
| Minnesota | 68 | 3.19 | 210 | 669.90 | 864 | 1.60 | 173 | 276.80 | 94 | 2 65 | 169 | 447.85 |
| Missouri | 133 | 2.73 | 226 | 616.98 | 1,387 | 1.49 | 254 | 378.46 | 202 | 2.15 | 209 | 449.35 |
| Montana | 6 | 3.00 | 83 | 249.00 | 14 | 2.51 | 123 | 308 73 | 1 | 3 00 | 200 | 600.00 |
| Nebraska | 20 | 2.30 | 176 | 404.80 | 272 | 1.59 | 152 | 241.68 | 23 | 2 74 | 124 | 339.76 |
| New Jersey | 11 | 1.79 | 258 | 461.82 | 158 | 1.28 | 215 | 275.20 | 8 | 1.60 | 291 | 465.60 |
| New Mexico | 1 | 3.00 | 120 | 360.00 | 8 | 2.82 | 54 | 152.28 | 2 | 2.00 | 65 | 130.00 |
| New York | 123 | 2.41 | 206 | 496.46 | 1,052 | 2.03 | 203 | 412.09 | 323 | 2.23 | 171 | 381.33 |
| Ohio | 145 | 1.96 | 218 | 427.28 | 1,490 | 1.44 | 215 | 309.60 | 161 | 1.86 | 206 | 383.16 |
| Pennsylvania | 166 | 2.31 | 225 | 519.75 | 3,270 | 1.20 | 222 | 266.40 | 191 | 1 76 | 215 | 378.40 |
| Rhode Island | 2 | 1.90 | 195 | 370.50 | 14 | 1.41 | 183 | 258.03 | 3 | 2.00 | 233 | 466.00 |
| South Carolina | 2 | 1.77 | 179 | 316.83 | 18 | 1.13 | 184 | 207.92 | 1 | 2 50 | 138 | 345.00 |
| Tennessee | 6 | 2.09 | 209 | 436.81 | 75 | 1.10 | 176 | 193.60 | 10 | 1.85 | 122 | 225.70 |
| Texas | 12 | 2.70 | 181 | 488.70 | 154 | 1.82 | 191 | 347.62 | 26 | 2.67 | 224 | 598.08 |
| Utah | 2 | 2.50 | 295 | 737.50 | 6 | 2.41 | 233 | 561.53 | 1 | 3 50 | 150 | 525.00 |
| Vermont | 12 | 1.78 | 258 | 459.24 | 79 | 1.33 | 221 | 293.93 | 26 | 1.52 | 271 | 411.92 |
| Virginia | 10 | 1.99 | 238 | 473.62 | 63 | 1.38 | 258 | 356.04 | 24 | 1.58 | 266 | 420.28 |
| Washington | 12 | 3.11 | 210 | 653.10 | 48 | 2.25 | 195 | 438.75 | 54 | 2.96 | 228 | 674.88 |
| West Virginia | 7 | 2.31 | 252 | 582.12 | 58 | 1.06 | 181 | 191 86 | 18 | 1.39 | 274 | 380.86 |
| Wisconsin | 42 | 2.05 | 234 | 479.70 | 637 | 1.44 | 212 | 305.28 | 77 | 1.85 | 238 | 440.30 |
| Other states (*a*) | 4 | 2.50 | 237 | 592.50 | 95 | 2.11 | 98 | 206.78 | 2 | 2.50 | 300 | 750.00 |

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*a*The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Arizona, Florida, Georgia, Oregon, South Dakota, and Wyoming.

LABOR AND WAGES CLASSIFIED, BY STATES AND TERRITORIES—Continued.

| STATES AND TERRITORIES. | LABORERS. | | | | BOYS UNDER 16 YEARS. | | | | OFFICE FORCE. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Average number. | Average daily wages. | Average number of days. | Average yearly earnings. | Average number. | Average daily wages. | Average number of days. | Average yearly earnings. | Average number. | Average annual salary. |
| Alabama | 534 | $1.00 | 205 | $205.00 | 31 | $0.51 | 234 | $119.34 | 14 | $655.62 |
| Arkansas | 8 | 1.38 | 156 | 215.28 | 4 | 0.51 | 112 | 57.12 | | |
| California | 170 | 2.02 | 242 | 488.84 | 1 | 1.50 | 85 | 127.50 | 5 | 887.50 |
| Colorado | 24 | 2.03 | 257 | 521.71 | | | | | 2 | 1,087.75 |
| Connecticut | 27 | 1.49 | 265 | 394.85 | | | | | 2 | 1,100.00 |
| Idaho | 2 | 1.77 | 80 | 141.60 | | | | | | |
| Illinois | 808 | 1.54 | 224 | 344.96 | 23 | 0.91 | 201 | 182.91 | 52 | 1,037.52 |
| Indiana | 1,440 | 1.37 | 298 | 408.26 | 99 | 0.69 | 180 | 124.20 | 69 | 842.60 |
| Iowa | 371 | 1.19 | 182 | 216.58 | 25 | 0.87 | 183 | 159.21 | 18 | 663.13 |
| Kansas | 223 | 1.43 | 182 | 260.26 | 18 | 0.74 | 138 | 102.12 | 18 | 537.14 |
| Kentucky | 219 | 1.01 | 137 | 138.37 | 23 | 0.59 | 149 | 87.91 | 7 | 996.14 |
| Maine | 260 | 1.75 | 269 | 470.75 | | | | | 15 | 880.00 |
| Maryland | 122 | 1.21 | 221 | 267.41 | 10 | 0.56 | 164 | 91.84 | 1 | 1,200.00 |
| Massachusetts | 24 | 1.32 | 152 | 200.64 | | | | | | |
| Michigan | 73 | 1.57 | 227 | 356.39 | | | | | | |
| Minnesota | 190 | 1.48 | 168 | 248.64 | 5 | 0.61 | 135 | 82.35 | 11 | 350.25 |
| Missouri | 1,422 | 1.70 | 213 | 362.10 | 36 | 0.85 | 188 | 159.80 | 40 | 947.31 |
| Montana | 26 | 2.25 | 162 | 364.50 | | | | | 1 | 500.00 |
| Nebraska | 177 | 1.54 | 118 | 181.72 | 4 | 1.00 | 160 | 160.00 | 10 | 521.88 |
| New Jersey | 48 | 1.22 | 185 | 225.70 | 2 | 0.62 | 205 | 127.10 | 3 | 1,100.00 |
| New Mexico | 7 | 1.45 | 43 | 62.35 | | | | | | |
| New York | 1,023 | 1.31 | 201 | 263.31 | 50 | 0.89 | 198 | 176.22 | 29 | 615.67 |
| Ohio | 737 | 1.35 | 220 | 297.00 | 46 | 0.68 | 151 | 102.68 | 47 | 691.55 |
| Pennsylvania | 1,094 | 1.29 | 192 | 247.68 | 54 | 0.71 | 203 | 144.13 | 57 | 729.58 |
| Rhode Island | 10 | 1.36 | 244 | 331.84 | | | | | 2 | 466.00 |
| South Carolina | 24 | 1.20 | 186 | 223.20 | 1 | 0.75 | 138 | 103.50 | | |
| Tennessee | 71 | 1.01 | 251 | 253.51 | | | | | 1 | 800.00 |
| Texas | 81 | 1.39 | 185 | 257.15 | 3 | 0.93 | 235 | 218.55 | 2 | 1,500.00 |
| Utah | 15 | 2.06 | 237 | 488.22 | 1 | 0.75 | 200 | 150.00 | 1 | 300.00 |
| Vermont | 49 | 1.03 | 235 | 242.05 | 3 | 0.75 | 136 | 102.00 | 1 | 900.00 |
| Virginia | 141 | 1.02 | 279 | 284.58 | 7 | 0.77 | 249 | 191.73 | 8 | 546.00 |
| Washington | 86 | 2.06 | 110 | 226.60 | 3 | 1.00 | 100 | 100.00 | 2 | 1,500.00 |
| West Virginia | 41 | 0.93 | 207 | 192.51 | | | | | 2 | 600.00 |
| Wisconsin | 270 | 1.39 | 208 | 289.12 | 9 | 0.80 | 186 | 148.80 | 13 | 876.67 |
| Other states (*a*) | 8 | 1.05 | 290 | 304.50 | 1 | 0.60 | 145 | 87.00 | | |

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*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Arizona, Florida, Georgia, Oregon, South Dakota, and Wyoming.

The following table shows the relative standing of various states according to various statistical items. It will be noticed that Pennsylvania stands at the head of all the lists except two, and as a limestone-producing state it is of the first importance. The items which contribute largely to the importance of Pennsylvania as a limestone state are the conversion of the stone into lime and that used for blast-furnace flux.

RELATIVE STANDING OF STATES AND TERRITORIES ACCORDING TO VARIOUS STATISTICAL ITEMS.

| TOTAL VALUE OF PRODUCTION. | | TOTAL CAPITAL IN LAND. | | TOTAL CAPITAL. | |
|---|---|---|---|---|---|
| States and territories. | Value. | States and territories. | Amount. | States and territories. | Amount. |
| Total | $19,095,179 | Total | $14,771,200 | Total | $27,022,325 |
| 1 Pennsylvania | 2,655,477 | Illinois | 1,998,575 | Pennsylvania | 3,402,345 |
| 2 Illinois | 2,190,607 | Pennsylvania | 1,799,915 | Illinois | 3,316,616 |
| 3 Indiana | 1,889,336 | New York | 1,612,160 | Indiana | 3,170,385 |
| 4 Missouri | 1,859,960 | Indiana | 1,478,190 | New York | 2,664,847 |
| 5 New York | 1,708,830 | Ohio | 1,311,130 | Ohio | 2,283,986 |
| 6 Maine | 1,523,499 | Missouri | 1,053,102 | Missouri | 2,066,017 |
| 7 Ohio | 1,514,934 | Wisconsin | 770,143 | Wisconsin | 1,397,986 |
| 8 Wisconsin | 813,963 | Minnesota | 628,440 | Minnesota | 1,186,847 |
| 9 Minnesota | 613,247 | Kansas | 528,313 | Maine | 1,120,500 |
| 10 Iowa | 530,863 | California | 525,515 | Iowa | 1,008,992 |
| 11 California | 516,780 | Maine | 514,200 | California | 857,409 |
| 12 Kansas | 478,822 | Iowa | 489,915 | Kansas | 734,301 |
| 13 Alabama | 324,814 | Washington | 333,320 | Washington | 584,825 |
| 14 Kentucky | 303,314 | Maryland | 262,745 | Kentucky | 510,189 |
| 15 Washington | 231,287 | Kentucky | 260,087 | Maryland | 418,168 |
| 16 Texas | 217,835 | Utah | 145,000 | Alabama | 353,071 |
| 17 Nebraska | 207,019 | Nebraska | 131,000 | Nebraska | 268,710 |
| 18 Vermont | 195,066 | Alabama | 124,500 | West Virginia | 217,188 |
| 19 Maryland | 164,860 | Michigan | 123,700 | Michigan | 184,318 |
| 20 Virginia | 159,023 | West Virginia | 120,058 | Colorado | 183,370 |
| 21 Colorado | 138,091 | Colorado | 107,450 | Vermont | 160,424 |
| 22 Connecticut | 131,697 | New Jersey | 84,797 | Utah | 155,225 |
| 23 New Jersey | 129,662 | Vermont | 64,250 | New Jersey | 152,539 |
| 24 Massachusetts | 119,978 | Virginia | 47,300 | Connecticut | 100,465 |
| 25 West Virginia | 93,856 | Connecticut | 37,650 | Virginia | 99,875 |
| 26 Michigan | 85,952 | Texas | 37,355 | Tennessee | 79,915 |
| 27 Tennessee | 73,028 | Tennessee | 32,890 | Massachusetts | 72,451 |
| 28 Idaho | 28,545 | Massachusetts | 30,350 | Texas | 69,705 |
| 29 Rhode Island | 27,625 | Arkansas | 27,650 | Montana | 39,500 |
| 30 Utah | 27,568 | Rhode Island | 25,000 | Rhode Island | 37,400 |
| 31 Montana | 24,964 | Montana | 21,000 | Arkansas | 32,531 |
| 32 Arkansas | 18,360 | Idaho | 14,700 | Idaho | 27,200 |
| 33 South Carolina | 14,520 | New Mexico | 11,800 | New Mexico | 19,600 |
| 34 New Mexico | 3,862 | South Carolina | 7,000 | South Carolina | 14,250 |
| Other states (*a*) | 77,935 | Other states | 12,000 | Other states | 31,175 |

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*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Arizona, Florida, Georgia, Oregon, South Dakota, and Wyoming.

RELATIVE STANDING OF STATES AND TERRITORIES ACCORDING TO VARIOUS STATISTICAL ITEMS—Continued.

| TOTAL NUMBER OF EMPLOYÉS. | | TOTAL AMOUNT OF WAGES PAID EMPLOYÉS. | | TOTAL COST OF SUPPLIES. | | TOTAL EXPENSES. | |
|---|---|---|---|---|---|---|---|
| States and territories. | Number. | States and territories. | Amount. | States and territories. | Amount. | States and territories. | Amount. |
| Total | 30, 644 | Total | $10, 121, 985 | Total | $4, 227, 246 | Total | $15, 092, 714 |
| 1 Pennsylvania | 4, 832 | Pennsylvania | 1, 421, 496 | Maine | 754, 845 | Pennsylvania | 2, 178, 013 |
| 2 Indiana | 3, 383 | Illinois | 1, 247, 097 | Pennsylvania | 620, 279 | Illinois | 1, 707, 938 |
| 3 Illinois | 3, 240 | Missouri | 1, 181, 115 | Illinois | 376, 687 | Missouri | 1, 523, 257 |
| 4 Missouri | 3, 220 | Indiana | 1, 025, 689 | New York | 337, 995 | Maine | 1, 474, 890 |
| 5 Ohio | 2, 626 | New York | 846, 623 | Indiana | 333, 625 | Indiana | 1, 423, 504 |
| 6 New York | 2, 600 | Ohio | 797, 082 | Missouri | 281, 565 | New York | 1, 268, 151 |
| 7 Iowa | 1, 254 | Maine | 679, 825 | Ohio | 280, 247 | Ohio | 1, 138, 070 |
| 8 Minnesota | 1, 232 | Minnesota | 367, 321 | Wisconsin | 226, 925 | Wisconsin | 617, 911 |
| 9 Kansas | 1, 201 | Wisconsin | 345, 184 | California | 175, 840 | Minnesota | 497, 498 |
| 10 Maine | 1, 063 | Iowa | 329, 442 | Minnesota | 102, 840 | Iowa | 432, 465 |
| 11 Wisconsin | 1, 048 | Kansas | 317, 480 | Iowa | 81, 210 | Kansas | 364, 049 |
| 12 Alabama | 837 | Alabama | 199, 480 | Vermont | 79, 199 | California | 354, 930 |
| 13 Kentucky | 777 | Kentucky | 194, 092 | Washington | 67, 595 | Alabama | 259, 118 |
| 14 Nebraska | 506 | California | 164, 615 | Connecticut | 60, 382 | Kentucky | 240, 744 |
| 15 California | 302 | Washington | 133, 215 | Maryland | 60, 064 | Washington | 211, 418 |
| 16 Maryland | 286 | Nebraska | 129, 906 | Alabama | 47, 980 | Nebraska | 164, 533 |
| 17 Texas | 278 | Texas | 96, 778 | Massachusetts | 46, 732 | Vermont | 141, 660 |
| 18 Virginia | 253 | Virginia | 80, 994 | New Jersey | 40, 588 | Maryland | 138, 703 |
| 19 New Jersey | 230 | Colorado | 73, 960 | Kansas | 35, 696 | Virginia | 116, 636 |
| 20 Washington | 205 | Maryland | 69, 980 | Virginia | 32, 831 | Texas | 114, 022 |
| 21 Vermont | 170 | New Jersey | 62, 926 | Kentucky | 29, 763 | New Jersey | 109, 492 |
| 22 Tennessee | 163 | Vermont | 55, 959 | Nebraska | 24, 390 | Connecticut | 108. 048 |
| 23 Michigan | 145 | Massachusetts | 47, 431 | West Virginia | 21, 002 | Massachusetts | 95, 831 |
| 24 West Virginia | 126 | Michigan | 44, 211 | Colorado | 18, 091 | Colorado | 94, 064 |
| 25 Colorado | 114 | Connecticut | 43, 186 | Texas | 13, 678 | Michigan | 58, 132 |
| 26 Massachusetts | 103 | Tennessee | 38, 040 | Michigan | 13, 191 | Tennessee | 51, 487 |
| 27 Connecticut | 95 | West Virginia | 28, 651 | Tennessee | 12, 190 | West Virginia | 51, 323 |
| 28 Arkansas | 50 | Montana | 16, 375 | Rhode Island | 12, 140 | Rhode Island | 22, 440 |
| 29 Montana | 48 | Utah | 13, 172 | Idaho | 5, 532 | Montana | 20, 350 |
| 30 South Carolina | 46 | Idaho | 11, 159 | Utah | 5, 405 | Utah | 19, 577 |
| 31 Rhode Island | 31 | Rhode Island | 9, 992 | Arkansas | 4, 023 | Idaho | 17, 301 |
| 32 Idaho | 26 | Arkansas | 9, 850 | Montana | 3, 800 | Arkansas | 14, 440 |
| 33 Utah | 26 | South Carolina | 8, 555 | South Carolina | 1, 835 | South Carolina | 11, 440 |
| 34 New Mexico | 18 | New Mexico | 1, 754 | New Mexico | 1, 195 | New Mexico | 3, 019 |
| Other states (*a*) | 110 | Other states | 29, 350 | Other states | 17, 886 | Other states | 48, 260 |

*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Arizona, Florida, Georgia, Oregon, South Dakota, and Wyoming.

The tables following give the relative standing of all states producing limestone according to the purposes for which the stone was used. The first table gives the standing according to value for these purposes, while the second refers to the number of cubic feet and the purposes. Considering the first table relative to value, it is evident that for building purposes Illinois stands first. The large amount devoted to building purposes in this state comes chiefly from the Joliet and Lemont quarry regions, and the product from these places is largely used for building. Indiana stands second in value, and the stone which contributes largely to the value given, namely, $994,313, is the oölitic limestone, which is exceptionally popular, not only in the immediate vicinity but in many of the larger and more important cities of the country, both east and west.

In regard to the value of lime produced, it appears that Maine heads the list. The product comes almost entirely from Knox county, where large quarries of very pure limestone are operated exclusively for the purpose of burning the product into lime. In the value of the lime produced Pennsylvania stands second, but by reference to the second table it will be noticed that Pennsylvania stands first, with a product of 4,043,679 barrels, while Maine stands second, with a product about one-half as great. There is evidently a great difference in favor of Maine in the value per barrel of the lime from these 2 states. This is accounted for by the fact that a large proportion of the lime produced in Pennsylvania is used for agricultural purposes, which require only inferior grades, whereas the lime from Maine is almost entirely used for building purposes in many of the most important cities on the Atlantic coast, principally New York city.

A small amount of stone is reported under the heading "Stone for burning into lime". This represents stone which was sold by quarrymen to lime burners. In connection with the use of limestone for flux, Pennsylvania naturally stands at the head of the list. The amount consumed for this purpose is quite large, being 2,583,926 tons, valued at $949,083. It is evident that there is a very great difference between Pennsylvania and other states in the consumption of limestone for this purpose.

For street work Missouri stands first, the amount being valued at $670,351. The limestone used for street work goes largely into macadamizing.

In connection with miscellaneous uses, it will be found that Kentucky has produced 150 cubic feet, with a value of $500. This item needs special explanation because of the exceedingly high value per cubic foot, namely, $3.33. The stone which has this high value is a quite highly siliceous limestone, and is used for purposes of polishing surfaces of marble, and also in polishing gold and silver previous to final buffing or polishing.

It will be noticed also that in Vermont 2,400 cubic feet are reported, with a value of $1,000. This product was used for grinding for the manufacture of paint.

RELATIVE STANDING OF STATES AND TERRITORIES ACCORDING TO VALUE AND PURPOSES.

| BUILDING PURPOSES. | | LIME. | | STONE FOR BURNING INTO LIME. | |
|---|---|---|---|---|---|
| States and territories. | Value. | States and territories. | Value. | States and territories. | Value. |
| Total | $5,405,671 | Total | $8,217,015 | Total | $184,024 |
| 1 Illinois | 1,084,556 | Maine | 1,523,499 | Ohio | 98,059 |
| 2 Indiana | 994,313 | Pennsylvania | 1,195,955 | Pennsylvania | 37,120 |
| 3 Missouri | 542,871 | New York | 837,613 | New York | 21,349 |
| 4 New York | 444,291 | Ohio | 581,325 | Virginia | 7,500 |
| 5 Ohio | 407,388 | Wisconsin | 514,974 | Wisconsin | 6,709 |
| 6 Minnesota | 380,556 | California | 513,130 | Alabama | 6,024 |
| 7 Kansas | 269,316 | Missouri | 465,390 | Colorado | 3,750 |
| 8 Pennsylvania | 238,431 | Illinois | 366,245 | Michigan | 3,313 |
| 9 Iowa | 236,792 | Indiana | 340,315 | Minnesota | 200 |
| 10 Wisconsin | 232,780 | Washington | 224,707 | | |
| 11 Kentucky | 187,570 | Alabama | 178,248 | | |
| 12 Texas | 135,901 | Iowa | 170,043 | | |
| 13 Nebraska | 90,542 | Vermont | 168,808 | | |
| 14 Michigan | 46,308 | Maryland | 148,432 | | |
| 15 Alabama | 37,981 | Connecticut | 129,663 | | |
| 16 Massachusetts | 21,833 | Minnesota | 124,266 | | |
| 17 Virginia | 19,520 | New Jersey | 99,406 | | |
| 18 Montana | 7,500 | Massachusetts | 93,702 | | |
| 19 Colorado | 7,300 | Colorado | 91,101 | | |
| 20 Vermont | 5,010 | Virginia | 83,667 | | |
| 21 West Virginia | 3,835 | West Virginia | 82,471 | | |
| 22 Utah | 2,600 | Tennessee | 60,625 | | |
| 23 Washington | 1,580 | Idaho | 28,545 | | |
| 24 Tennessee | 1,336 | Rhode Island | 27,500 | | |
| 25 Arkansas | 1,260 | Kentucky | 24,414 | | |
| 26 New Mexico | 1,211 | Nebraska | 16,722 | | |
| 27 Maryland | 1,140 | Michigan | 15,500 | | |
| 28 Connecticut | 894 | Arkansas | 14,600 | | |
| 29 New Jersey | 636 | Utah | 10,300 | | |
| 30 California | 360 | Kansas | 9,013 | | |
| 31 | | Texas | 6,700 | | |
| 32 | | South Carolina | 6,120 | | |
| 33 | | New Mexico | 2,331 | | |
| 34 | | Montana | 1,464 | | |
| Other states (*a*) | 60 | Other states | 60,221 | | |

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*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Arizona, Florida, Georgia, Oregon, South Dakota, and Wyoming.

## RELATIVE STANDING OF STATES AND TERRITORIES ACCORDING TO VALUE AND PURPOSES—Continued.

| | FLUXING FOR FURNACES. | | STREET WORK. | | BRIDGE, DAM, AND RAILROAD WORK. | | MISCELLANEOUS. | |
|---|---|---|---|---|---|---|---|---|
| | States and territories. | Value. | States and territories. | Value. | States and territories. | Value. | States and territories. | Value. |
| | Total | $1,569,312 | Total | $2,383,456 | Total | $1,289,622 | Total | $46,079 |
| 1 | Pennsylvania | 949,083 | Missouri | 670,351 | Indiana | 233,710 | Ohio | 14,446 |
| 2 | Illinois | 166,507 | Illinois | 505,576 | New York | 175,736 | Pennsylvania | 6,723 |
| 3 | Ohio | 105,963 | Indiana | 316,722 | Missouri | 169,720 | Minnesota | 6,430 |
| 4 | Alabama | 92,761 | New York | 197,091 | Pennsylvania | 155,653 | Missouri | 5,937 |
| 5 | Virginia | 48,146 | Ohio | 183,235 | Ohio | 124,518 | Indiana | 3,220 |
| 6 | Colorado | 35,940 | Kansas | 97,502 | Kansas | 102,991 | Massachusetts | 2,000 |
| 7 | New York | 32,750 | Nebraska | 86,643 | Minnesota | 90,017 | Illinois | 1,961 |
| 8 | New Jersey | 29,620 | Kentucky | 86,054 | Iowa | 70,387 | California | 1,900 |
| 9 | Montana | 16,000 | Pennsylvania | 72,512 | Illinois | 65,762 | Arkansas | 1,350 |
| 10 | Utah | 14,668 | Iowa | 53,641 | Texas | 30,919 | Vermont | 1,000 |
| 11 | Texas | 12,037 | Texas | 32,278 | Wisconsin | 23,070 | Nebraska | 612 |
| 12 | Nebraska | 10,000 | Wisconsin | 27,789 | Vermont | 18,150 | Kentucky | 500 |
| 13 | Wisconsin | 8,641 | Michigan | 18,156 | South Carolina | 8,400 | | |
| 14 | West Virginia | 7,200 | Minnesota | 11,778 | Tennessee | 4,867 | | |
| 15 | Maryland | 6,750 | Alabama | 9,800 | Kentucky | 3,178 | | |
| 16 | Missouri | 5,691 | Maryland | 6,750 | Nebraska | 2,500 | | |
| 17 | Washington | 5,000 | Tennessee | 3,400 | Maryland | 1,788 | | |
| 18 | Tennessee | 2,800 | Vermont | 2,098 | Arkansas | 650 | | |
| 19 | Michigan | 2,675 | California | 1,390 | West Virginia | 350 | | |
| 20 | Massachusetts | 2,443 | Arkansas | 500 | | | | |
| 21 | Kentucky | 1,598 | Virginia | 190 | | | | |
| 22 | Connecticut | 1,140 | | | | | | |
| 23 | Indiana | 1,056 | | | | | | |
| 24 | New Mexico | 320 | | | | | | |
| 25 | Rhode Island | 125 | | | | | | |
| | Other states (*a*) | 10,398 | | | Other states | 7,256 | | |

## RELATIVE STANDING OF STATES AND TERRITORIES ACCORDING TO AMOUNTS AND PURPOSES.

| | BUILDING PURPOSES. | | LIME. | | STONE FOR BURNING INTO LIME. | |
|---|---|---|---|---|---|---|
| | States and territories. | Cubic feet. | States and territories. | Barrels. | States and territories. | Tons. |
| | Total | 92,289,896 | Total | 18,474,668 | Total | 478,082 |
| 1 | Illinois | 21,433,967 | Pennsylvania | 4,043,679 | Ohio | 220,095 |
| 2 | Missouri | 11,083,370 | Maine | 1,903,639 | Pennsylvania | 137,285 |
| 3 | Ohio | 9,754,989 | Ohio | 1,725,336 | New York | 43,003 |
| 4 | Indiana | 7,402,345 | New York | 1,636,148 | Wisconsin | 21,833 |
| 5 | Minnesota | 7,277,348 | Wisconsin | 1,561,611 | Colorado | 15,000 |
| 6 | New York | 7,154,747 | Missouri | 1,144,962 | Virginia | 15,000 |
| 7 | Iowa | 6,280,787 | Indiana | 1,074,517 | Michigan | 13,466 |
| 8 | Pennsylvania | 5,188,013 | Illinois | 877,274 | Alabama | 12,000 |
| 9 | Kansas | 4,562,049 | Maryland | 545,591 | Minnesota | 400 |
| 10 | Wisconsin | 4,537,351 | California | 533,123 | | |
| 11 | Nebraska | 2,058,614 | New Jersey | 400,249 | | |
| 12 | Kentucky | 1,854,917 | Iowa | 365,394 | | |
| 13 | Michigan | 1.296,539 | Alabama | 350,340 | | |
| 14 | Texas | 666,160 | Minnesota | 344,102 | | |
| 15 | Virginia | 471,505 | Vermont | 324,148 | | |
| 16 | Massachusetts | 283,100 | West Virginia | 296,498 | | |
| 17 | West Virginia | 194,250 | Washington | 222,759 | | |
| 18 | Montana | 160,000 | Connecticut | 191,795 | | |
| 19 | Alabama | 154,480 | Virginia | 178,480 | | |
| 20 | Utah | 120,865 | Colorado | 146,737 | | |
| 21 | Vermont | 95,040 | Tennessee | 113,228 | | |
| 22 | Colorado | 56,250 | Massachusetts | 82,977 | | |
| 23 | New Mexico | 49,675 | Kentucky | 66,376 | | |
| 24 | Maryland | 41,807 | Michigan | 44,173 | | |
| 25 | Connecticut | 33,750 | Nebraska | 41,805 | | |
| 26 | New Jersey | 28,058 | Arkansas | 37,600 | | |
| 27 | Washington | 15,970 | Rhode Island | 32,100 | | |
| 28 | California | 12,500 | Idaho | 29,871 | | |
| 29 | Tennessee | 11,510 | Kansas | 16,686 | | |
| 30 | Arkansas | 9,100 | Utah | 16,480 | | |
| 31 | | | South Carolina | 13,500 | | |
| 32 | | | Texas | 12,000 | | |
| 33 | | | New Mexico | 2,850 | | |
| 34 | | | Montana | 2.217 | | |
| | Other states (*a*) | 840 | Other states | 96,423 | | |

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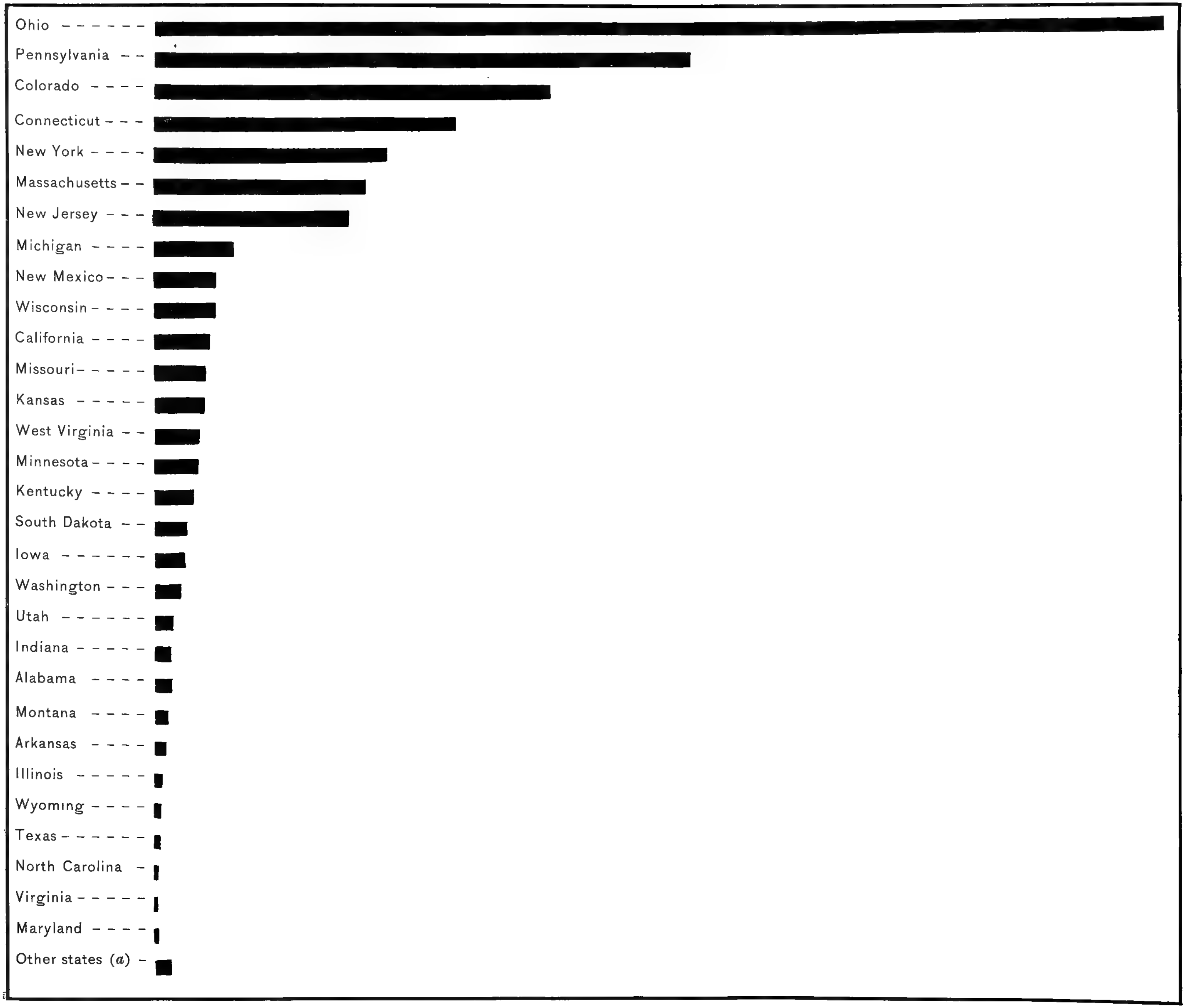
*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Arizona, Florida, Georgia, Oregon, South Dakota, and Wyoming.

RELATIVE STANDING OF STATES AND TERRITORIES ACCORDING TO AMOUNTS AND PURPOSES—Continued.

| FLUXING FOR FURNACES. | | STREET WORK. | | BRIDGE, DAM, AND RAILROAD WORK. | | MISCELLANEOUS. | |
|---|---|---|---|---|---|---|---|
| States and territories. | Tons. | States and territories. | Cubic feet. | States and territories. | Cubic feet. | States and territories. | Cubic feet. |
| Total | 3, 894, 337 | Total | 46, 491, 622 | Total | 26, 679, 012 | Total | 549, 875 |
| 1 Pennsylvania | 2, 583, 926 | Missouri | 11, 542, 723 | Missouri | 5, 471, 386 | Ohio | 173, 788 |
| 2 Illinois | 300, 182 | Illinois | 10, 221, 392 | Ohio | 4, 984, 581 | Minnesota | 87, 300 |
| 3 Ohio | 280, 626 | Ohio | 7, 236, 981 | Pennsylvania | 3, 714, 444 | Pennsylvania | 60, 688 |
| 4 Alabama | 247, 761 | New York | 5, 241, 262 | Kansas | 2, 532, 801 | Nebraska | 56, 500 |
| 5 New York | 84, 222 | Indiana | 2, 614, 862 | Wisconsin | 2, 048, 954 | Massachusetts | 50, 000 |
| 6 Virginia | 78, 756 | Pennsylvania | 2, 042, 804 | Iowa | 1, 732, 630 | Indiana | 31, 400 |
| 7 New Jersey | 59, 275 | Nebraska | 1, 926, 469 | New York | 1, 434, 115 | California | 31, 250 |
| 8 Colorado | 51, 851 | Kentucky | 1, 762, 711 | Indiana | 1, 410, 285 | Missouri | 29, 688 |
| 9 Utah | 32, 596 | Iowa | 1, 707, 931 | Illinois | 969, 899 | Arkansas | 13, 500 |
| 10 Nebraska | 21, 600 | Kansas | 771, 041 | Minnesota | 868, 144 | Illinois | 13, 211 |
| 11 West Virginia | 21, 600 | Wisconsin | 488, 811 | Texas | 638, 921 | Vermont | 2, 400 |
| 12 Wisconsin | 21, 564 | Michigan | 485, 377 | Vermont | 445, 500 | Kentucky | 150 |
| 13 Montana | 17, 000 | Maryland | 145, 670 | Tennessee | 115, 182 | | |
| 14 Texas | 16, 455 | Alabama | 98, 000 | South Carolina | 56, 700 | | |
| 15 Missouri | 13, 488 | Minnesota | 68, 788 | Maryland | 43, 680 | | |
| 16 Michigan | 10, 957 | Texas | 67, 750 | Arkansas | 32, 500 | | |
| 17 Maryland | 10, 080 | California | 35, 000 | West Virginia | 25, 000 | | |
| 18 Washington | 7, 000 | Tennessee | 14, 500 | Kentucky | 14, 715 | | |
| 19 Tennessee | 5, 000 | Vermont | 9, 990 | Nebraska | 10, 000 | | |
| 20 Massachusetts | 4, 309 | Virginia | 7, 560 | | | | |
| 21 Connecticut | 3, 468 | Arkansas | 2, 000 | | | | |
| 22 Kentucky | 3, 244 | | | | | | |
| 23 Indiana | 2, 640 | | | | | | |
| 24 New Mexico | 400 | | | | | | |
| 25 Rhode Island | 50 | | | | | | |
| Other states (*a*) | 16, 287 | | | Other states | 129, 575 | | |

*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Arizona, Florida, Georgia, Oregon, South Dakota, and Wyoming.

The table on the following page gives general deductions in regard to a number of important items. In comparing the percentage of profit on capital and on sales for the state of Maine, it will be noticed that the figures 4.34 and 3.19 are very much lower than in most of the other states. The excessively high figures which occur in a few places are generally accounted for by the newness of the industry or the small amount produced.



RELATIVE RANK OF STATES PRODUCING SANDSTONE.

*a* **Arizona, Florida, Georgia, Idaho, Nevada, New Hampshire, Oregon, Rhode Island, Tennessee, and Vermont.**

GENERAL STATISTICS OF PRODUCTION IN 1889, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | Total value of product. | Total wages. | Total expenses. | Total capital. | PERCENTAGE OF PROFIT ON— | | Percentage of wages to total expenses. | Percentage of wages to total value. |
|---|---|---|---|---|---|---|---|---|
| | | | | | Capital. | Value of product. | | |
| Total | $19,095,179 | $10,121,985 | $15,092,714 | $27,022,325 | 14.81 | 20.96 | 67.07 | 53.01 |
| Alabama | 324,814 | 199,480 | 259,118 | 353,071 | 18.61 | 20.23 | 76.98 | 61.41 |
| Arkansas | 18,360 | 9,850 | 14,440 | 32,531 | 12.05 | 21.35 | 68.21 | 53.65 |
| California | 516,780 | 164,615 | 354,930 | 857,409 | 18.88 | 31.32 | 46.38 | 31.85 |
| Colorado | 138,091 | 73,960 | 94,064 | 183,370 | 24.01 | 31.88 | 78.63 | 53.56 |
| Connecticut | 131,697 | 43,186 | 108,048 | 100,465 | 23.54 | 17.96 | 39.97 | 32.79 |
| Idaho | 28,545 | 11,159 | 17,301 | 27,200 | 41.34 | 39.39 | 64.50 | 39.09 |
| Illinois | 2,190,607 | 1,247,097 | 1,707,938 | 3,316,616 | 14.55 | 22.03 | 73.02 | 56.93 |
| Indiana | 1,889,336 | 1,025,689 | 1,423,504 | 3,170,385 | 14.69 | 24.66 | 72.05 | 54.29 |
| Iowa | 530,863 | 329,442 | 432,465 | 1,608,992 | 9.75 | 18.54 | 76.18 | 62.06 |
| Kansas | 478,822 | 317,480 | 364,049 | 734,301 | 15.63 | 23.97 | 87.21 | 66.30 |
| Kentucky | 303,314 | 194,092 | 240,744 | 510,189 | 12.26 | 20.63 | 80.62 | 63.99 |
| Maine | 1,523,499 | 679,825 | 1,474,890 | 1,120,500 | 4.34 | 3.19 | 46.09 | 44.62 |
| Maryland | 164,860 | 69,980 | 138,703 | 418,168 | 6.26 | 15.87 | 50.45 | 42.45 |
| Massachusetts | 119,978 | 47,431 | 95,831 | 72,451 | 33.33 | 20.13 | 49.49 | 39.53 |
| Michigan | 85,952 | 44,211 | 58,132 | 184,318 | 15.09 | 32.37 | 76.05 | 51.44 |
| Minnesota | 613,247 | 367,321 | 497,498 | 1,186,847 | 9.75 | 18.87 | 73.83 | 59.90 |
| Missouri | 1,859,960 | 1,181,115 | 1,523,257 | 2,066,017 | 16.30 | 18.10 | 77.54 | 63.50 |
| Montana | 24,964 | 16,375 | 20,350 | 39,500 | 11.68 | 18.48 | 80.47 | 65.59 |
| Nebraska | 207,019 | 129,906 | 164,533 | 268,710 | 15.81 | 20.52 | 78.95 | 62.75 |
| New Jersey | 129,662 | 62,926 | 109,492 | 152,539 | 13.22 | 15.56 | 57.47 | 48.53 |
| New Mexico | 3,862 | 1,754 | 3,019 | 19,600 | 4.30 | 21.83 | 58.10 | 45.42 |
| New York | 1,708,830 | 846,623 | 1,268,151 | 2,664,847 | 16.54 | 25.79 | 66.76 | 49.54 |
| Ohio | 1,514,934 | 797,082 | 1,138,070 | 2,283,986 | 16.50 | 24.88 | 70.04 | 52.61 |
| Pennsylvania | 2,655,477 | 1,421,496 | 2,178,013 | 3,402,345 | 14.03 | 17.98 | 65.27 | 53.53 |
| Rhode Island | 27,625 | 9,992 | 22,440 | 37,400 | 13.86 | 18.77 | 44.53 | 36.17 |
| South Carolina | 14,520 | 8,555 | 11,440 | 14,250 | 21.61 | 21.21 | 74.78 | 58.92 |
| Tennessee | 73,028 | 38,040 | 51,487 | 79,915 | 26.95 | 29.50 | 73.88 | 52.09 |
| Texas | 217,835 | 96,778 | 114,022 | 69,705 | 148.93 | 47.66 | 84.88 | 44.43 |
| Utah | 27,568 | 13,172 | 19,577 | 155,225 | 5.15 | 28.99 | 67.28 | 47.78 |
| Vermont | 195,066 | 55,959 | 141,660 | 160,424 | 33.29 | 27.38 | 39.50 | 28.69 |
| Virginia | 159,023 | 80,994 | 116,636 | 99,875 | 42.44 | 26.65 | 69.44 | 50.93 |
| Washington | 231,287 | 133,215 | 211,418 | 584,825 | 3.40 | 8.59 | 63.01 | 57.60 |
| West Virginia | 93,856 | 28,651 | 51,323 | 217,188 | 19.58 | 45.32 | 55.82 | 30.53 |
| Wisconsin | 813,963 | 345,184 | 617,911 | 1,397,986 | 14.02 | 24.09 | 55.86 | 42.41 |
| Other states (*a*) | 77,935 | 29,350 | 48,260 | 31,175 | 95.19 | 38.08 | 60.82 | 37.66 |

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*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Arizona, Florida, Georgia, Oregon, South Dakota, and Wyoming.

# SANDSTONE.

The name "sandstone" is applied to stone which has been formed by sedimentary deposit from water of granules which have resulted from the disintegration of older rocks by various kinds of dynamic action, weathering, and erosion. Naturally, therefore, grains of quartz, the hardest essential component of the older rocks, are vastly more abundant in sandstone than all other minerals; indeed, most sandstones are almost entirely made up of particles of quartz. Other minerals, however, occur. Various varieties of feldspar and mica are frequently found, while small amounts of still other minerals are occasionally observed, but there is by no means the variety which characterizes the constitution of granitic and volcanic rocks.

The size of the granules composing sandstone is quite variable, giving rise to the distinction between the fine and coarse grained varieties.

The granules constituting sandstone are usually held together by some cementing material, and the nature of the latter is an all-important consideration bearing upon the strength, durability, and beauty of the stone, and, consequently, upon its value as a structural material. Some sandstones are apparently without this cementing or binding material, and are particularly desirable as abrasive material, although they may also form good building stone.

Lithologically considered, the different kinds of sandstone are classed with reference to the cementing material rather than to the mineralogical nature of the component granules. Argillaceous sandstone is one in which the cementing material is clay, and in cases where the clay has not been subjected to metamorphic action such stone is subject to disintegration under the influences of weather.

In calcareous sandstone the cementing material is calcium carbonate, and when the latter is present in great xcess the stone is called siliceous limestone. Limestone being readily acted upon by acids, disintegration may asily result from atmospheric agencies.

Ferruginous sandstone is one in which the cementing material consists of oxides of iron, which determine the olor of the stone when it is pink, red, brown, or shades intermediate between those named.

Siliceous sandstone is that in which the cementing material is silica, so that the rock consists of almost pure ilica. Such stone is usually hard, durable, capable of withstanding great crushing strength, and is not subject o alteration in color, and, as a consequence of its extreme hardness, it is naturally difficult to work. This kind rades into quartzite, which has been hardened by heat and pressure.

Freestone is a name of popular origin, and is applied to such sandstones as work well in any direction. The erms "arkose", "conglomerate", and "breccia" are names which have special reference to the character of the ranules present. Arkose is composed of the constituents of granitic rocks which have been disintegrated and econsolidated into sandstone, and conglomerate is a sandstone in which the granules are rounded pebbles instead f small grains. When these fragments are angular instead of rounded it is called breccia.

The terms "quartzose", "feldspathic", and "micaceous" sandstone refer to the presence of the minerals implied y these names.

The following table of analyses of sandstone from a number of localities will serve to indicate its general omposition:

ANALYSES OF SANDSTONE.

[Per cent.]

| | KINDS OF STONE. | Locality. | Silica. | Alumina. | Iron oxides. | Manganese oxide. | Lime. | Magnesia. | Potash. | Soda. | Carbonic acid, water, and loss. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Manyard | East Longmeadow, Massachusetts | 79.38 | 8.75 | 2.43 | .......... | 2.57 | .......... | 4.08 | | 2.79 |
| 2 | Worcester | East Longmeadow, Massachusetts | 88.89 | 5.95 | 1.79 | 0.41 | 0.27 | .......... | 0.86 | | 1.83 |
| 3 | Kibbie quartz | East Longmeadow, Massachusetts | 81.38 | 9.44 | 3.54 | 0.11 | 0.76 | 0.28 | .......... | .......... | 4.49 |
| 4 | Brownstone | Portland, Connecticut | 69.94 | 13.15 | 2.48 | 0.70 | 3.09 | Trace. | 3.30 | 5.43 | 1.01 |
| 5 | Sandstone | Stony Point, Michigan | 84.57 | 5.90 | 6.48 | .......... | .......... | 0.68 | Undetermined. | | 1.92 |
| 6 | Quartzite | Pipestone, Minnesota | 84.52 | 12.33 | 2.12 | .......... | 0.31 | Trace. | 0.11 | 0.34 | 2.31 |
| 7 | Buff | Amherst, Ohio | 97.00 | .......... | 1.00 | .......... | 1.15 | .......... | 0.64 | | 0.21 |
| 8 | Berea | Berea, Ohio | 96.90 | .......... | 1.68 | .......... | 0.55 | .......... | 0.55 | | 0.32 |
| 9 | Euclid bluestone | Euclid, Ohio | 95.00 | 2.50 | 1.00 | .......... | .......... | .......... | .......... | .......... | 1.50 |
| 0 | Columbia | Columbia, Ohio | 96.50 | .......... | .......... | .......... | 1.00 | .......... | 0.50 | | 2.00 |
| 1 | Red | Laurel Run, Pennsylvania | 94.00 | Trace. | 1.90 | .......... | 1.10 | 1.00 | .......... | .......... | 1.92 |
| 2 | Elyria | Grafton, Ohio | 87.66 | 1.72 | 3.52 | .......... | 0.17 | 0.20 | .......... | .......... | 2.03 |
| 3 | Sandstone | Fond du Lac, Minnesota | 78.24 | 10.88 | 3.83 | .......... | 0.95 | 1.60 | 1.67 | 0.06 | .......... |

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The commercial names of sandstone are usually found by reference to the places at which they are quarried, as ortland brownstone, Berea grit, etc.

In connection with this report it should be carefully noted that the stone commercially known as bluestone, in o far as it comes from certain sections of the states of New York, New Jersey, and Pennsylvania, is not included ere, but is specially treated in another report under the title of "Bluestone". The Tenth Census report included luestone with sandstone from the above-named states, which is scientifically correct, but the difference in the ractical applications of bluestone from the states named and the other kinds of sandstone is so well defined ommercially that it was thought best to separate bluestone and treat of it in a report by itself.

The table following shows the relative standing of productive states according to the Tenth and Eleventh ensuses. The states are arranged in the order of value of output. It is evident from this that, while 18 states nly were productive in 1880, the number has now reached 40. Ohio holds first place in both columns. At the enth Census New York held second place, but it must be remembered that bluestone is included in the figures given or value of output. At the present time New York holds fifth place, and the apparent decline is due to the exclusion f bluestone. According to the Eleventh Census Colorado holds third place, while 10 years ago it held sixteenth lace among the productive states. The vast increase in the sandstone production of this state, namely, from $9,000 o $1,224,098, is due largely to the operations of the Union Pacific Railway Company. This company is not only one f the most extensive producing concerns, but the facilities for shipment which they afford to other large producers ccount in a great measure for the striking increase in production. Enormous shipments of sandstone are now made rom Colorado to remote parts of the United States, and the business is in a most flourishing condition. Another otable change is the appearance of California as a productive state, holding eleventh place. This state does not ppear among the 18 states of the Tenth Census.

### COMPARISON OF VALUE OF OUTPUT OF SANDSTONE AND RANK OF STATES AND TERRITORIES AT THE TENTH AND ELEVENTH CENSUSES.

| Rank. | TENTH CENSUS, INCLUDING BLUESTONE. States and territories. | Value of output. | Rank. | ELEVENTH CENSUS, NOT INCLUDING BLUESTONE. States and territories. | Value of output. |
|---|---|---|---|---|---|
| | Total | $4,780,391 | | Total | $10,816,057 |
| 1 | Ohio | 1,871,924 | 1 | Ohio | 3,046,656 |
| 2 | New York | 724,556 | 2 | Pennsylvania | 1,609,159 |
| 3 | Connecticut | 680,200 | 3 | Colorado | 1,224,098 |
| 4 | Pennsylvania | 627,943 | 4 | Connecticut | 920,061 |
| 5 | New Jersey | 400,420 | 5 | New York | 702,419 |
| 6 | Massachusetts | 144,294 | 6 | Massachusetts | 649,097 |
| 7 | Missouri | 81,960 | 7 | New Jersey | 597,309 |
| 8 | Michigan | 53,080 | 8 | Michigan | 246,570 |
| 9 | Minnesota | 41,150 | 9 | New Mexico | 186,804 |
| 10 | Indiana | 40,400 | 10 | Wisconsin | 183,958 |
| 11 | Wisconsin | 37,745 | 11 | California | 175,598 |
| 12 | Illinois | 21,830 | 12 | Missouri | 155,557 |
| 13 | West Virginia | 16,689 | 13 | Kansas | 149,289 |
| 14 | Dakota | 12,000 | 14 | West Virginia | 140,687 |
| 15 | Kansas | 11,000 | 15 | Minnesota | 131,979 |
| 16 | Colorado | 9,000 | 16 | Kentucky | 117,940 |
| 17 | Iowa | 4,200 | 17 | South Dakota | 93,570 |
| 18 | Washington | 2,000 | 18 | Iowa | 80,251 |
| | | | 19 | Washington | 75,936 |
| | | | 20 | Utah | 48,306 |
| | | | 21 | Indiana | 43,983 |
| | | | 22 | Alabama | 43,965 |
| | | | 23 | Montana | 31,648 |
| | | | 24 | Arkansas | 25,074 |
| | | | 25 | Illinois | 17,896 |
| | | | 26 | Wyoming | 16,760 |
| | | | 27 | Texas | 14,651 |
| | | | 28 | North Carolina | 12,000 |
| | | | 29 | Virginia | 11,500 |
| | | | 30 | Maryland | 10,605 |
| | | | 31 | Arizonia | 9,146 |
| | | | 32 | Oregon | 8,424 |
| | | | 33 | New Hampshire | 3,750 |
| | | | 34 | Tennessee | 2,722 |
| | | | 35 | Idaho | 2,490 |
| | | | | Other states (*a*) | 26,199 |

*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Florida, Georgia, Nevada, Rhode Island, and Vermont.

It is evident that the increase in production during the last 10 years amounted to $6,035,666, or 126.26 per cent. The 18 states which were productive in both census years produced sandstone in 1889 to the value of $10,068,475, or 93.09 per cent of the entire product, not, however, including bluestone. The 22 other states produced to the value of $747,582 in 1889, or 6.91 per cent of the total amount. It is thus apparent that, although the number of states producing sandstone is now more than twice as great as in 1880, nearly the entire output comes from the same states that were productive 10 years ago.

The following table shows the comparison in detail of the 18 states producing in 1880 and 1889, and also gives the percentage of increase or decrease for each:

COMPARISON OF STATES AND TERRITORIES PRODUCTIVE IN 1880 AND 1889.

| Rank in Tenth Census. | STATES AND TERRITORIES. | Value of output at Tenth Census. | Value of output at Eleventh Census. | Per cent increase. | Rank in Eleventh Census. |
|---|---|---|---|---|---|
| | Total | $4, 780, 391 | $10, 068, 475 | 110. 62 | |
| 1 | Ohio | 1, 871, 924 | 3, 046, 656 | 62. 76 | 1 |
| 2 | New York | 724, 556 | 702, 419 | a3. 06 | 5 |
| 3 | Connecticut | 680, 200 | 920, 061 | 35. 26 | 4 |
| 4 | Pennsylvania | 627, 943 | 1, 609, 159 | 156. 26 | 2 |
| 5 | New Jersey | 400, 420 | 597, 309 | 49. 17 | 7 |
| 6 | Massachusetts | 144, 294 | 649, 097 | 349. 84 | 6 |
| 7 | Missouri | 81, 960 | 155, 557 | 89. 80 | 12 |
| 8 | Michigan | 53, 080 | 246, 570 | 364. 53 | 8 |
| 9 | Minnesota | 41, 150 | 131, 979 | 220. 73 | 15 |
| 10 | Indiana | 40, 400 | 43, 983 | 8. 87 | 21 |
| 11 | Wisconsin | 37, 745 | 183, 958 | 387. 37 | 10 |
| 12 | Illinois | 21, 830 | 17, 896 | a18. 02 | 25 |
| 13 | West Virginia | 16, 689 | 140, 687 | 742. 99 | 14 |
| 14 | Dakota and South Dakota | 12, 000 | 93, 570 | 679. 75 | 17 |
| 15 | Kansas | 11, 000 | 149, 289 | 1, 257. 17 | 13 |
| 16 | Colorado | 9, 000 | 1, 224, 098 | 13, 501. 09 | 3 |
| 17 | Iowa | 4, 200 | 80, 251 | 1, 810. 74 | 18 |
| 18 | Washington | 2, 000 | 75, 936 | 3, 696. 80 | 19 |

*a* Decrease.

The following table shows the amount yielded by states and territories not productive in 1880:

ELEVENTH CENSUS STATES AND TERRITORIES NOT REPRESENTED IN TENTH CENSUS.

| Rank. | STATES AND TERRITORIES. | Value. | Rank. | STATES AND TERRITORIES. | Value. |
|---|---|---|---|---|---|
| | Total | $747, 582 | 28 | North Carolina | $12, 000 |
| | | | 29 | Virginia | 11, 500 |
| 9 | New Mexico | 186, 804 | 30 | Maryland | 10, 605 |
| 11 | California | 175, 598 | 31 | Arizona | 9, 146 |
| 16 | Kentucky | 117, 940 | 32 | Oregon | 8, 424 |
| 20 | Utah | 48, 306 | 33 | New Hampshire | 3, 750 |
| 22 | Alabama | 43, 965 | 34 | Tennessee | 2, 722 |
| 23 | Montana | 31, 648 | 35 | Idaho | 2, 490 |
| 24 | Arkansas | 25, 074 | | Other states (*a*) | 26, 199 |
| 26 | Wyoming | 16, 760 | | | |
| 27 | Texas | 14, 651 | | | |

*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Florida, Georgia, Nevada, Rhode Island, and Vermont.

The following table shows for both census years the geographical distribution of sandstone: (*a*)

COMPARISON OF TENTH AND ELEVENTH CENSUSES BY DIVISIONS AND VALUES.

| DIVISIONS. | Eleventh Census. | Tenth Census. | Increase. | Per cent increase. |
|---|---|---|---|---|
| Total | $10, 816, 057 | $4, 780, 391 | $6, 035, 666 | 126. 26 |
| North Atlantic | 4, 504, 165 | 2, 577, 413 | 1, 926, 752 | 74. 76 |
| South Atlantic | 176, 292 | 16, 689 | 159, 603 | 956. 34 |
| North Central | 4, 149, 709 | 2, 175, 289 | 1, 974, 420 | 90. 77 |
| South Central | 204, 352 | .......... | 204, 352 | .......... |
| Western | 1, 781, 539 | 11, 000 | 1, 770, 539 | 16, 095. 81 |

*a* The states and territories included in the various divisions are as follows:

NORTH ATLANTIC DIVISION.—New Hampshire, Massachusetts, Connecticut, New Jersey, Vermont, Rhode Island, New York, Pennsylvania.

SOUTH ATLANTIC DIVISION,—Maryland, West Virginia, Florida, Georgia, Virginia, North Carolina.

NORTH CENTRAL DIVISION.—Ohio, Illinois, Wisconsin, Iowa, South Dakota, Indiana, Michigan, Minnesota, Missouri, Kansas.

SOUTH CENTRAL DIVISION.—Kentucky, Alabama, Arkansas, Tennessee, Texas.

WESTERN DIVISION.—Montana, Colorado, Arizona, Nevada, Washington, California, Wyoming, New Mexico, Utah, Idaho, Oregon.

It is evident that in both censuses the North Atlantic division was the most productive, the North Central division following closely in value of production. The Western division stands third for the Eleventh Census, with a product amounting to $1,781,539, while the third position for the Tenth Census is occupied by the South Atlantic division. Fourth place for the Eleventh Census is filled by the South Central division, in which at the Tenth Census no sandstone was produced. Fifth place for the Eleventh Census is occupied by the South Atlantic division, which produced only a small amount 10 years ago. The great bulk of the sandstone production comes, therefore, at present from the North Atlantic and North Central divisions, the South Atlantic and the South Central producing very little in comparison, while the Western division shows the enormous increase in 10 years from $11,000 to $1,781,539.

The following table, the states and territories being arranged in alphabetical order, gives all totals relative to the sandstone output for the calendar year 1889. From the grand total for the United States it appears that 71,571,054 cubic feet of sandstone, having a total value of $10,816,057, were produced by 16,925 workmen from 803 quarries. To this number of men $6,257,580 was paid in wages. The total expense of producing the entire amount of sandstone is $8,130,295, thus indicating a profit to the producers of $2,685,762. The total capital invested is $17,776,467, of which $11,501,100 is invested in land.

PRODUCTION OF SANDSTONE IN THE UNITED STATES IN 1889, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | Number of quarries. | PRODUCTION. |  | LABOR. |  |  |  |  |  |  | POWER. |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  | Cubic feet. | Value. | Total employed. | Foremen. | Quarrymen. | Mechanics and stonecutters. | Laborers. | Boys under 16 years. | Office force. | Number of boilers. | Total horse power of boilers. | Number of animals. | Other power. |
| Total | 803 | 71, 571, 054 | $10, 816, 057 | 16, 925 | 782 | 7, 746 | 1, 983 | 5, 912 | 250 | 252 | 553 | 15, 182 | 2, 851 | 165 |
| Alabama | 5 | 610, 026 | 43, 965 | 127 | 5 | 53 | 9 | 54 | 5 | 1 | ........ | ........ | 9 | ........ |
| Arizona | 2 | 127, 907 | 9, 146 | 13 | 1 | 10 | ........ | 2 | ........ | ........ | ........ | ........ | 3 | ........ |
| Arkansas | 8 | 210, 010 | 25, 074 | 50 | 3 | 24 | 9 | 14 | ........ | ........ | 1 | 12 | 8 | ........ |
| California | 15 | 333, 209 | 175, 598 | 222 | 10 | 114 | 31 | 64 | 2 | 1 | 2 | 20 | 33 | 20 |
| Colorado | 71 | 6, 570, 529 | 1. 224, 098 | 1, 485 | 90 | 854 | 187 | 313 | 8 | 33 | 21 | 535 | 298 | ........ |
| Connecticut | 13 | 2, 821, 430 | 920, 061 | 1, 092 | 45 | 814 | 58 | 150 | 5 | 20 | 66 | 2, 111 | 294 | ........ |
| Idaho | 2 | 28, 710 | 2, 490 | 5 | ........ | 3 | ........ | 2 | ........ | ........ | ........ | ........ | 4 | ........ |
| Illinois | 10 | 141, 605 | 17, 896 | 46 | 4 | 33 | 1 | 8 | ........ | ........ | 2 | 24 | 14 | ........ |
| Indiana | 11 | 334, 441 | 43, 983 | 188 | 12 | 71 | 25 | 67 | 11 | 2 | 7 | 113 | 35 | ........ |
| Iowa | 11 | 404, 350 | 80, 251 | 142 | 8 | 41 | 21 | 63 | 3 | 6 | 4 | 130 | 18 | ........ |
| Kansas | 17 | 680, 289 | 149, 289 | 329 | 11 | 159 | 57 | 88 | 4 | 10 | 4 | 88 | 84 | ........ |
| Kentucky | 11 | 888, 738 | 117, 940 | 302 | 15 | 126 | 43 | 105 | 11 | 2 | 10 | 162 | 39 | ........ |
| Maryland | 4 | 508, 325 | 10, 605 | 43 | 2 | 39 | ........ | ........ | 2 | ........ | 1 | 50 | 8 | ........ |
| Massachusetts | 21 | 1, 967, 179 | 649, 097 | 906 | 28 | 358 | 161 | 347 | 2 | 10 | 33 | 782 | 289 | ........ |
| Michigan | 6 | 658, 318 | 246, 570 | 345 | 9 | 132 | 31 | 166 | 5 | 2 | 11 | 320 | 24 | ........ |
| Minnesota | 7 | 4, 156, 224 | 131, 979 | 205 | 10 | 151 | 16 | 22 | 5 | 1 | 6 | 139 | 15 | ........ |
| Missouri | 17 | 734, 370 | 155, 557 | 192 | 12 | 80 | 17 | 77 | 3 | 3 | 15 | 282 | 36 | ........ |
| Montana | 6 | 644, 740 | 31, 648 | 69 | 6 | 57 | 1 | 2 | 2 | 1 | 2 | 26 | 24 | ........ |
| New Hampshire | 2 | 21, 665 | 3, 750 | 13 | 2 | 9 | 1 | ........ | 1 | ........ | 2 | 30 | 4 | ........ |
| New Jersey | 26 | 6, 010, 212 | 597, 309 | 866 | 38 | 299 | 130 | 378 | 11 | 10 | 24 | 569 | 191 | ........ |
| New Mexico | 11 | 588, 048 | 186, 804 | 377 | 11 | 217 | 47 | 87 | 11 | 4 | 3 | 82 | 98 | ........ |
| New York | 63 | 4, 878, 365 | 702, 419 | 1, 569 | 58 | 568 | 183 | 738 | 10 | 12 | 30 | 470 | 302 | 75 |
| North Carolina | 2 | 50, 000 | 12, 000 | 53 | 1 | 4 | 2 | 40 | 5 | 1 | 4 | 100 | 3 | ........ |
| Ohio | 192 | 16, 016, 258 | 3, 046, 656 | 4, 095 | 187 | 1, 660 | 506 | 1, 610 | 54 | 78 | 231 | 7, 310 | 400 | 70 |
| Oregon | 2 | 50, 000 | 8, 424 | 7 | ........ | 5 | ........ | 2 | ........ | ........ | 1 | 15 | 6 | ........ |
| Pennsylvania | 159 | 17, 414, 875 | 1, 609, 159 | 2, 932 | 140 | 1, 262 | 337 | 1, 102 | 66 | 25 | 44 | 1, 167 | 376 | ........ |
| South Dakota | 12 | 341, 875 | 93, 570 | 140 | 9 | 64 | 18 | 43 | ........ | 6 | 2 | 54 | 36 | ........ |
| Tennessee | 4 | 53, 978 | 2, 722 | 33 | 2 | 22 | 2 | 4 | 1 | 2 | 1 | 30 | 2 | ........ |
| Texas | 7 | 180, 591 | 14, 651 | 42 | 3 | 16 | 4 | 19 | ........ | ........ | ........ | ........ | 12 | ........ |
| Utah | 7 | 145, 726 | 48, 306 | 61 | 6 | 28 | 1 | 25 | ........ | 1 | 3 | 40 | 10 | ........ |
| Virginia | 3 | 70, 800 | 11, 500 | 37 | 3 | 20 | 5 | 8 | 1 | ........ | ........ | ........ | 17 | ........ |
| Washington | 5 | 540, 039 | 75, 936 | 105 | 6 | 57 | 10 | 29 | 1 | 2 | 3 | 89 | 2 | ........ |
| West Virginia | 27 | 964, 263 | 140, 687 | 337 | 23 | 136 | 28 | 133 | 13 | 4 | 5 | 162 | 20 | ........ |
| Wisconsin | 32 | 1, 146, 736 | 183, 958 | 373 | 15 | 199 | 39 | 103 | 5 | 12 | 14 | 260 | 48 | ........ |
| Wyoming | 7 | 197, 775 | 16, 760 | 69 | 5 | 32 | 1 | 28 | 2 | 1 | 1 | 10 | 44 | ........ |
| Other states (*a*) | 5 | 1, 079, 448 | 26, 199 | 55 | 2 | 29 | 2 | 19 | 1 | 2 | ........ | ........ | 45 | ........ |

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*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Florida, Georgia, Nevada, Rhode Island, and Vermont.

PRODUCTION OF SANDSTONE IN THE UNITED STATES IN 1889, BY STATES AND TERRITORIES—Continued.

| STATES AND TERRITORIES. | EXPENSES. | | | | CAPITAL. | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total expenses. | Total wages. | Cost of supplies. | All other expenses. | Total capital. | Land. | Buildings and fixtures. | Tools, live stock, machinery, and supplies. | Cash. |
| Total | $8, 130, 295 | $6, 257, 580 | $1, 277, 004 | $595, 711 | $17, 776, 467 | $11, 501, 100 | $1, 492, 850 | $3, 044, 557 | $1, 737, 960 |
| Alabama | 48, 587 | 41, 562 | 5, 600 | 1, 425 | 18, 535 | 8, 000 | 1, 535 | 3, 800 | 5, 200 |
| Arizona | 3, 742 | 2, 542 | 1, 200 | ........... | 35, 000 | 19, 400 | 350 | 15, 250 | ........... |
| Arkansas | 12, 860 | 11, 287 | 1, 122 | 451 | 17, 660 | 9, 750 | 2, 200 | 2, 510 | 3, 200 |
| California | 147, 264 | 122, 847 | 16, 729 | 7, 688 | 400, 950 | 278, 000 | 33, 600 | 49, 150 | 40, 200 |
| Colorado | 902, 768 | 772, 158 | 76, 831 | 53, 779 | 2, 009, 484 | 1, 507, 255 | 100, 300 | 220, 860 | 181, 069 |
| Connecticut | 710, 772 | 528, 089 | 127. 402 | 55, 281 | 1, 896, 957 | 1, 190, 606 | 234, 992 | 292, 398 | 178, 961 |
| Idaho | 1, 940 | 1, 350 | 75 | 515 | 10, 250 | 6, 200 | 3, 500 | 550 | ........... |
| Illinois | 10, 808 | 8, 937 | 977 | 894 | 49, 400 | 33, 450 | 1, 900 | 5, 625 | 8, 425 |
| Indiana | 43, 232 | 37, 387 | 4, 663 | 1, 182 | 169, 225 | 113, 700 | 7, 400 | 40, 925 | 7, 200 |
| Iowa | 71, 014 | 56, 714 | 11, 387 | 2, 913 | 178, 455 | 86, 870 | 6, 115 | 71, 710 | 13, 760 |
| Kansas | 117, 594 | 105, 507 | 8, 855 | 3, 232 | 324, 135 | 194, 510 | 18, 025 | 32, 600 | 79, 000 |
| Kentucky | 86, 102 | 62, 745 | 14, 223 | 9, 134 | 196, 580 | 90, 468 | 12, 822 | 41, 200 | 52, 090 |
| Maryland | 9, 271 | 7, 749 | 410 | 1, 112 | 41, 000 | 27, 480 | 1, 700 | 7, 770 | 4, 050 |
| Massachusetts | 509, 649 | 414, 282 | 51, 051 | 44, 316 | 373, 862 | 130, 550 | 37, 170 | 126, 851 | 79, 291 |
| Michigan | 127, 962 | 102, 094 | 11, 529 | 14, 339 | 609, 877 | 215, 402 | 104, 025 | 177, 500 | 112, 950 |
| Minnesota | 103, 107 | 74, 110 | 23, 301 | 5, 696 | 407, 090 | 328, 000 | 16, 590 | 52, 900 | 9, 600 |
| Missouri | 81, 773 | 69, 549 | 8, 806 | 3, 418 | 298, 380 | 201, 100 | 14, 150 | 57, 480 | 25, 650 |
| Montana | 31, 454 | 27, 881 | 3, 473 | 100 | 70, 400 | 46, 300 | 6, 650 | 9, 450 | 8, 000 |
| New Hampshire | 3, 621 | 3, 138 | 403 | 80 | 22, 310 | 15, 300 | 2, 500 | 4, 010 | 500 |
| New Jersey | 452, 657 | 380, 767 | 48, 012 | 23, 878 | 793, 115 | 488, 650 | 45, 075 | 127, 313 | 132, 077 |
| New Mexico | 139. 309 | 122, 730 | 14, 750 | 1, 829 | 421, 500 | 366, 400 | 24, 022 | 21, 605 | 9, 473 |
| New York | 571. 381 | 522, 702 | 39, 017 | 9, 662 | 879, 380 | 567, 880 | 69, 155 | 153, 522 | 88. 823 |
| North Carolina | 9, 600 | 7, 500 | 2, 000 | 100 | 70, 000 | 40, 000 | 5, 000 | 25, 000 | ........... |
| Ohio | 2, 277, 735 | 1, 450, 266 | 585, 635 | 241, 834 | 5, 075, 660 | 3, 455, 499 | 372, 045 | 869, 686 | 378, 430 |
| Oregon | 4, 400 | 3, 600 | 500 | 300 | 53, 000 | 50, 000 | 1, 000 | 2, 000 | ........... |
| Pennsylvania | 1, 180, 324 | 943, 641 | 143, 174 | 93, 509 | 1, 927, 410 | 1, 081, 894 | 250, 484 | 382, 781 | 212, 251 |
| South Dakota | 90, 213 | 65, 434 | 19, 075 | 5, 704 | 303, 770 | 240, 300 | 14, 965 | 40, 505 | 8, 000 |
| Tennessee | 2, 603 | 2, 119 | 182 | 302 | 12, 988 | 7, 520 | 800 | 4, 168 | 500 |
| Texas | 11, 520 | 8, 993 | 1, 855 | 672 | 12, 185 | 10, 650 | 850 | 635 | 50 |
| Utah | 44, 321 | 33, 598 | 10, 470 | 253 | 123, 575 | 81, 125 | 30, 200 | 10, 250 | 2, 000 |
| Virginia | 8, 629 | 8, 000 | 570 | 59 | 9, 180 | 4, 700 | 300 | 1, 180 | 3, 000 |
| Washington | 54, 955 | 45, 722 | 8, 650 | 583 | 78, 700 | 30, 000 | 13, 600 | 11, 100 | 24, 000 |
| West Virginia | 80, 704 | 72, 269 | 6, 037 | 2, 398 | 181, 158 | 114, 478 | 8, 070 | 36, 510 | 22, 100 |
| Wisconsin | 138, 543 | 110, 509 | 19, 724 | 8, 310 | 550, 822 | 319, 615 | 50, 010 | 133, 787 | 47, 410 |
| Wyoming | 22, 871 | 18, 283 | 3, 950 | 638 | 139, 348 | 130, 048 | 1, 500 | 7, 300 | 500 |
| Other states (*a*) | 17, 010 | 11. 519 | 5, 366 | 125 | 15, 126 | 10, 000 | 250 | 4, 676 | 200 |

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*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Florida, Georgia, Nevada, Rhode Island, and Vermont.

The table on the following pages is presented for the purpose of showing by states and territories as well as for the entire country the purposes to which sandstone is applied. It will be seen that they are as follows: building purposes; street work; abrasive purposes; bridge, dam, and railroad work, and miscellaneous uses. In order that these general purposes may be understood, the detailed list of uses which come under one or another of the general headings in the table is presented.

## DETAILED LIST OF USES OF SANDSTONE.

### FOUNDATIONS, SUPERSTRUCTURES, AND TRIMMINGS.

- Solid fronts.
- Foundations.
- Cellar walls.
- Underpinning.
- Steps.
- Buttresses.
- Window sills.
- Lintels.
- Kiln stone.
- Capping.
- Belting or belt courses.
- Rubble.
- Ashlar.
- Forts.
- Dimension.
- Sills.

### STREET WORK.

- Paving blocks.
- Curbing.
- Flagging.
- Basin heads or catch-basin covers.
- Stepping stones.
- Road making:
  - Macadam.
  - Telford.
  - Concrete.
- Sledged stone.
- Crushed stone.

### ABRASIVE PURPOSES.

- Grindstones.
- Whetstones.
- Shoe rubbers.
- Oilstones.

### BRIDGE, DAM, AND RAILROAD WORK.

- Bridges.
- Culverts.
- Aqueducts.
- Dams.
- Wharfstone.
- Breakwater.
- Jetties.
- Piers.
- Buttresses.
- Capstone.
- Rails.
- Ballast.
- Approaches.
- Towers.
- Bank stone.
- Parapets.
- Docks.
- Bridge covering.

### MISCELLANEOUS.

- Grout.
- Hitching posts.
- Fence wall.
- Sand for glass.
- Sand for plaster and cement.
- Furnace hearths.
- Lining for blast furnaces.
- Rolling-mill furnaces.
- Adamantine plaster.
- Millstones.
- Cemetery work.
- Watering troughs.
- Fluxing.
- Ganister.
- Fire brick, silica brick.
- Lining for steel converters.
- Glass furnaces.
- Core sand for foundries.
- Random stock.

## DISTRIBUTION OF SANDSTONE ACCORDING TO ITS SEVERAL USES, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | Number of quarries. | Total number of cubic feet. | Total value. | BUILDING PURPOSES. | | | STREET WORK. | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Cubic feet. | Value. | Value per cubic foot. | Cubic feet. | Value. | Value per cubic foot. |
| Total | 803 | 71, 571, 054 | $10, 816, 057 | 44, 979, 241 | $7, 121, 942 | $0. 16 | 8, 463, 506 | $1, 832, 822 | $0. 22 |
| Alabama | 5 | 610, 026 | 43, 965 | 542, 700 | 31, 310 | 0. 06 | | | |
| Arizona | 2 | 127, 907 | 9, 146 | 42, 250 | 1, 750 | 0. 04 | | | |
| Arkansas | 8 | 210, 010 | 25, 074 | 139, 950 | 12, 359 | 0. 09 | 27, 160 | 8, 215 | 0. 30 |
| California | 15 | 333, 209 | 175, 598 | 330, 275 | 172, 758 | 0. 52 | 100 | 200 | 2. 00 |
| Colorado | 71 | 6, 570, 529 | 1, 224, 098 | 4, 601, 965 | 703, 477 | 0. 15 | 1, 926, 464 | 509, 955 | 0. 26 |
| Connecticut | 13 | 2, 821, 430 | 920, 061 | 2, 524, 895 | 894, 226 | 0. 35 | 40, 500 | 2, 250 | 0. 06 |
| Idaho | 2 | 28, 710 | 2, 490 | 28, 710 | 2, 490 | 0. 09 | | | |
| Illinois | 10 | 141, 605 | 17, 896 | 82, 799 | 13, 178 | 0. 16 | 3, 200 | 50 | 0. 02 |
| Indiana | 11 | 334, 441 | 43, 983 | 104, 600 | 16, 033 | 0. 15 | | | |
| Iowa | 11 | 404, 350 | 80, 251 | 394, 870 | 79, 356 | 0. 20 | 8, 840 | 880 | 0. 10 |
| Kansas | 17 | 680, 289 | 149, 289 | 225, 774 | 17, 026 | 0. 08 | 452, 015 | 132, 188 | 0. 29 |
| Kentucky | 11 | 888, 738 | 117, 940 | 485, 363 | 77, 877 | 0. 16 | 13, 900 | 1, 600 | 0. 12 |
| Maryland | 4 | 508, 325 | 10, 605 | 63, 269 | 1, 944 | 0. 03 | 40, 320 | 2, 045 | 0. 05 |
| Massachusetts | 21 | 1, 967, 179 | 649, 097 | 1, 344, 850 | 602, 137 | 0. 45 | 501, 221 | 40, 471 | 0. 08 |
| Michigan | 6 | 658, 318 | 246, 570 | 606, 182 | 217, 720 | 0. 36 | 2, 496 | 550 | 0. 22 |
| Minnesota | 7 | 4, 156, 224 | 131, 979 | 1, 088, 870 | 82, 000 | 0. 08 | 51, 930 | 38, 200 | 0. 74 |
| Missouri | 17 | 734, 370 | 155, 557 | 469, 187 | 113, 445 | 0. 24 | 6, 533 | 2, 512 | 0. 38 |
| Montana | 6 | 644, 740 | 31, 648 | 644, 740 | 31, 648 | 0. 05 | | | |
| New Hampshire | 2 | 21, 665 | 3, 750 | | | | | | |
| New Jersey | 26 | 6, 010, 212 | 597, 309 | 4, 607, 767 | 486, 788 | 0. 11 | | | |
| New Mexico | 11 | 588, 048 | 186, 804 | 545, 648 | 182, 184 | 0. 33 | 10, 000 | 3, 000 | 0. 30 |
| New York | 63 | 4, 878, 365 | 702, 419 | 1, 960, 277 | 241, 216 | 0. 12 | 2, 864, 366 | 459, 158 | 0. 16 |
| North Carolina | 2 | 50, 000 | 12, 000 | 50, 000 | 12, 000 | 0. 24 | | | |
| Ohio | 192 | 16, 016, 258 | 3, 046, 656 | 10, 122, 544 | 1, 846, 918 | 0. 18 | 1, 603, 614 | 430, 552 | 0. 27 |
| Oregon | 2 | 50, 000 | 8, 424 | 50, 000 | 8, 424 | 0. 17 | | | |
| Pennsylvania | 159 | 17, 414, 875 | 1, 609, 159 | 9, 864, 139 | 777, 123 | 0. 08 | 854, 907 | 175, 062 | 0. 20 |
| South Dakota | 12 | 341, 875 | 93, 570 | 317, 751 | 81, 949 | 0. 26 | | | |
| Tennessee | 4 | 53, 978 | 2, 722 | 45, 878 | 2, 632 | 0. 06 | | | |
| Texas | 7 | 180, 591 | 14, 651 | 180, 591 | 14, 651 | 0. 08 | | | |
| Utah | 7 | 145, 726 | 48, 306 | 145, 726 | 48, 306 | 0. 33 | | | |
| Virginia | 3 | 70, 800 | 11, 500 | 70, 800 | 11, 500 | 0. 16 | | | |
| Washington | 5 | 540, 039 | 75, 936 | 540, 039 | 75, 936 | 0. 14 | | | |
| West Virginia | 27 | 964, 263 | 140, 687 | 412, 053 | 40, 149 | 0. 10 | 42, 075 | 23, 274 | 0. 55 |
| Wisconsin | 32 | 1, 146, 736 | 183, 958 | 1, 087, 856 | 182, 333 | 0. 17 | | | |
| Wyoming | 7 | 197, 775 | 16, 760 | 197, 775 | 16, 760 | 0. 08 | | | |
| Other states (*a*) | 5 | 1, 079, 448 | 26, 199 | 1, 059, 148 | 22, 339 | 0. 02 | 13, 865 | 2, 660 | 0. 19 |

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*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Florida, Georgia, Nevada, Rhode Island, and Vermont.

DISTRIBUTION OF SANDSTONE ACCORDING TO ITS SEVERAL USES, BY STATES AND TERRITORIES—Continued.

| STATES AND TERRITORIES. | ABRASIVE PURPOSES. | | | BRIDGE, DAM, AND RAILROAD WORK. | | | MISCELLANEOUS. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Cubic feet. | Value. | Value per cubic foot. | Cubic feet. | Value. | Value per cubic foot. | Cubic feet. | Value. | Value per cubic foot. |
| Total | 1, 378, 535 | $580, 229 | $0. 42 | 13, 614, 390 | $1, 021, 920 | $0. 080 | 3, 135, 382 | $259, 144 | $0. 08 |
| Alabama | | | | 67, 326 | 12, 655 | 0. 190 | | | |
| Arizona | | | | 85, 657 | 7, 396 | 0. 090 | | | |
| Arkansas | | | | | | | 42, 900 | 4, 500 | 0. 10 |
| California | 448 | 440 | 0. 98 | | | | 2, 386 | 2, 200 | 0. 92 |
| Colorado | | | | 42, 100 | 10, 666 | 0. 250 | | | |
| Connecticut | | | | 256, 035 | 23, 585 | 0. 090 | | | |
| Idaho | | | | | | | | | |
| Illinois | | | | 55, 606 | 4, 668 | 0. 080 | | | |
| Indiana | 3, 813 | 9, 870 | 2. 59 | 226, 028 | 18, 080 | 0. 080 | | | |
| Iowa | | | | 640 | 15 | 0. 020 | | | |
| Kansas | | | | 2, 500 | 75 | 0. 030 | | | |
| Kentucky | | | | 389, 475 | 38, 463 | 0. 100 | | | |
| Maryland | | | | 255, 041 | 3, 368 | 0. 010 | 149, 695 | 3, 248 | 0. 02 |
| Massachusetts | | | | 121, 108 | 6, 489 | 0. 050 | | | |
| Michigan | 44, 640 | 27, 800 | 0. 62 | 5, 000 | 500 | 0. 100 | | | |
| Minnesota | | | | 3, 015, 424 | 11, 779 | 0. 004 | | | |
| Missouri | | | | 258, 650 | 39, 600 | 0. 150 | | | |
| Montana | | | | | | | | | |
| New Hampshire | 21, 665 | 3, 750 | 0. 17 | | | | | | |
| New Jersey | | | | 1, 302, 445 | 100, 521 | 0. 080 | 100, 000 | 10, 000 | 0. 10 |
| New Mexico | | | | 32, 400 | 1, 620 | 0. 050 | | | |
| New York | | | | 9, 840 | 445 | 0. 050 | 43, 882 | 1, 600 | 0. 04 |
| North Carolina | | | | | | | | | |
| Ohio | 1, 277, 410 | 525, 548 | 0. 41 | 2, 026, 314 | 166, 114 | 0. 080 | 986, 376 | 77, 524 | 0. 08 |
| Oregon | | | | | | | | | |
| Pennsylvania | | | | 4, 885, 686 | 496, 902 | 0. 100 | 1, 810, 143 | 160, 072 | 0. 09 |
| South Dakota | 24, 124 | 11, 621 | 0. 48 | | | | | | |
| Tennessee | | | | 8, 100 | 90 | 0. 010 | | | |
| Texas | | | | | | | | | |
| Utah | | | | | | | | | |
| Virginia | | | | | | | | | |
| Washington | | | | | | | | | |
| West Virginia | | | | 510, 135 | 77, 264 | 0. 150 | | | |
| Wisconsin | | | | 58, 880 | 1, 625 | 0. 030 | | | |
| Wyoming | | | | | | | | | |
| Other states (*a*) | 6, 435 | 1, 200 | 0. 19 | | | | | | |

*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Florida, Georgia, Nevada, Rhode Island, and Vermont.

Glancing over this table, it appears that $7,121,942 worth of stone is applied to building purposes, while $1,832,822 worth has been applied to street work. Abrasive purposes have consumed an amount valued at $580,229, while for bridge, dam, and railroad work $1,021,920 worth was used. For miscellaneous purposes the amount is $259,144. Although the value of the stone for abrasive purposes is comparatively small, it is important to note that the quality of stone applied to these purposes is necessarily very fine, and consequently has a decidedly higher average value per cubic foot than that used for any other purpose. It will be noticed that there is quite a variation in the value per cubic foot of the stone used for different purposes, and in some cases for the same purpose. This is due to a variety of causes, among which may be mentioned variations in the quality of the stone, distance from any competing sources, rates of wages, etc.

The tables following give the relative standing of the states and territories, first, according to value and purposes, and, second, according to number of cubic feet and purposes.

### RELATIVE STANDING OF STATES AND TERRITORIES ACCORDING TO VALUE AND PURPOSES.

| BUILDING PURPOSES. | | STREET WORK. | | ABRASIVE PURPOSES. | | BRIDGE, DAM, AND RAILROAD WORK. | | MISCELLANEOUS. | |
|---|---|---|---|---|---|---|---|---|---|
| States and territories. | Value. | States and territories. | Value. | States and territories. | Value. | States and territories. | Value. | States and territories. | Value. |
| Total | $7,121,942 | Total | $1,832,822 | Total | $580,229 | Total | $1,021,920 | Total | $259,144 |
| 1 Ohio | 1,846,918 | Colorado | 509,955 | Ohio | 525,548 | Pennsylvania | 496,902 | Pennsylvania | 160,072 |
| 2 Connecticut | 894,226 | New York | 459,158 | Michigan | 27,800 | Ohio | 166,114 | Ohio | 77,524 |
| 3 Pennsylvania | 777,123 | Ohio | 430,552 | South Dakota | 11,621 | New Jersey | 100,521 | New Jersey | 10,000 |
| 4 Colorado | 703,477 | Pennsylvania | 175,062 | Indiana | 9,870 | West Virginia | 77,264 | Arkansas | 4,500 |
| 5 Massachusetts | 602,137 | Kansas | 132,188 | New Hampshire | 3,750 | Missouri | 39,600 | Maryland | 3,248 |
| 6 New Jersey | 486,788 | Massachusetts | 40,471 | California | 440 | Kentucky | 38,463 | California | 2,200 |
| 7 New York | 241,216 | Minnesota | 38,200 | | | Connecticut | 23,585 | New York | 1 600 |
| 8 Michigan | 217,720 | West Virginia | 23,274 | | | Indiana | 18,080 | | |
| 9 Wisconsin | 182,333 | Arkansas | 8,215 | | | Alabama | 12,655 | | |
| 10 New Mexico | 182,184 | New Mexico | 3,000 | | | Minnesota | 11,779 | | |
| 11 California | 172,758 | Missouri | 2,512 | | | Colorado | 10,666 | | |
| 12 Missouri | 113,445 | Connecticut | 2,250 | | | Arizona | 7,396 | | |
| 13 Minnesota | 82,000 | Maryland | 2,045 | | | Massachusetts | 6,489 | | |
| 14 South Dakota | 81,949 | Kentucky | 1,600 | | | Illinois | 4,668 | | |
| 15 Iowa | 79,356 | Iowa | 880 | | | Maryland | 3,368 | | |
| 16 Kentucky | 77,877 | Michigan | 550 | | | Wisconsin | 1,625 | | |
| 17 Washington | 75,936 | California | 200 | | | New Mexico | 1,620 | | |
| 18 Utah | 48,306 | Illinois | 50 | | | Michigan | 500 | | |
| 19 West Virginia | 40,149 | | | | | New York | 445 | | |
| 20 Montana | 31,648 | | | | | Tennessee | 90 | | |
| 21 Alabama | 31,310 | | | | | Kansas | 75 | | |
| 22 Kansas | 17,026 | | | | | Iowa | 15 | | |
| 23 Wyoming | 16,760 | | | | | | | | |
| 24 Indiana | 16,033 | | | | | | | | |
| 25 Texas | 14,651 | | | | | | | | |
| 26 Illinois | 13,178 | | | | | | | | |
| 27 Arkansas | 12,359 | | | | | | | | |
| 28 North Carolina | 12,000 | | | | | | | | |
| 29 Virginia | 11,500 | | | | | | | | |
| 30 Oregon | 8,424 | | | | | | | | |
| 31 Tennessee | 2,632 | | | | | | | | |
| 32 Idaho | 2,490 | | | | | | | | |
| 33 Maryland | 1,944 | | | | | | | | |
| 34 Arizona | 1,750 | | | | | | | | |
| Other states (*a*) | 22,339 | Other states | 2,660 | Other states | 1,200 | | | | |

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*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Florida, Georgia, Nevada, Rhode Island, and Vermont.

RELATIVE STANDING OF STATES AND TERRITORIES ACCORDING TO CUBIC FEET AND PURPOSES.

| | BUILDING PURPOSES. | | STREET WORK. | | ABRASIVE PURPOSES. | | BRIDGE, DAM, AND RAILROAD WORK. | | MISCELLANEOUS. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | States and territories. | Cubic feet. | States and territories. | Cubic feet. | States and territories. | Cubic feet. | States and territories. | Cubic feet. | States and territories. | Cubic feet. |
| | Total | 44,979,241 | Total | 8,463,506 | Total | 1,378,535 | Total | 13,614,390 | Total | 3,135,382 |
| 1 | Ohio | 10,122,544 | New York | 2,864,366 | Ohio | 1,277,410 | Pennsylvania | 4,885,686 | Pennsylvania | 1,810,143 |
| 2 | Pennsylvania | 9,864,139 | Colorado | 1,926,464 | Michigan | 44,640 | Minnesota | 3,015,424 | Ohio | 986,376 |
| 3 | New Jersey | 4,607,767 | Ohio | 1,603,614 | South Dakota | 24,124 | Ohio | 2,026,314 | Maryland | 149,695 |
| 4 | Colorado | 4,601,965 | Pennsylvania | 854,907 | New Hampshire | 21,665 | New Jersey | 1,302,445 | New Jersey | 100,000 |
| 5 | Connecticut | 2,524,895 | Massachusetts | 501,221 | Indiana | 3,813 | West Virginia | 510.135 | New York | 43,882 |
| 6 | New York | 1,960,277 | Kansas | 452,015 | California | 448 | Kentucky | 389,475 | Arkansas | 42,900 |
| 7 | Massachusetts | 1,344,850 | Minnesota | 51,930 | | | Missouri | 258,650 | California | 2,386 |
| 8 | Minnesota | 1,088,870 | West Virginia | 42,075 | | | Connecticut | 256,035 | | |
| 9 | Wisconsin | 1,087,856 | Connecticut | 40,500 | | | Maryland | 255,041 | | |
| 10 | Montana | 644,740 | Maryland | 40,320 | | | Indiana | 226,028 | | |
| 11 | Michigan | 606,182 | Arkansas | 27,160 | | | Massachusetts | 121,108 | | |
| 12 | New Mexico | 545,648 | Kentucky | 13,900 | | | Arizona | 85,657 | | |
| 13 | Alabama | 542,700 | New Mexico | 10,000 | | | Alabama | 67,326 | | |
| 14 | Washington | 540,039 | Iowa | 8,840 | | | Wisconsin | 58,880 | | |
| 15 | Kentucky | 485,363 | Missouri | 6,533 | | | Illinois | 55,606 | | |
| 16 | Missouri | 469,187 | Illinois | 3,200 | | | Colorado | 42,100 | | |
| 17 | West Virginia | 412,053 | Michigan | 2,496 | | | New Mexico | 32,400 | | |
| 18 | Iowa | 394,870 | California | 100 | | | New York | 9,840 | | |
| 19 | California | 330,275 | | | | | Tennessee | 8,100 | | |
| 20 | South Dakota | 317,751 | | | | | Michigan | 5,000 | | |
| 21 | Kansas | 225,774 | | | | | Kansas | 2,500 | | |
| 22 | Wyoming | 197,775 | | | | | Iowa | 640 | | |
| 23 | Texas | 180,591 | | | | | | | | |
| 24 | Utah | 145,726 | | | | | | | | |
| 25 | Arkansas | 139,950 | | | | | | | | |
| 26 | Indiana | 104,600 | | | | | | | | |
| 27 | Illinois | 82,799 | | | | | | | | |
| 28 | Virginia | 70,800 | | | | | | | | |
| 29 | Maryland | 63,269 | | | | | | | | |
| 30 | Oregon | 50,000 | | | | | | | | |
| 31 | North Carolina | 50,000 | | | | | | | | |
| 32 | Tennessee | 45,878 | | | | | | | | |
| 33 | Arizona | 42,250 | | | | | | | | |
| 34 | Idaho | 28,710 | | | | | | | | |
| | Other states (*a*) | 1,059,148 | Other states | 13,865 | Other states | 6,435 | | | | |

*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Florida, Georgia, Nevada, Rhode Island, and Vermont.

It is evident that for building and abrasive purposes Ohio holds first place, while for street work Colorado stands first. It is also interesting to note that only 7 states produce sandstone suitable for abrasive purposes. These in the order of importance are Ohio, Michigan, Indiana, New Hampshire, Vermont, California, and South Dakota. The vast difference in the value of stone for abrasive purposes produced by Ohio as compared with the other states is very striking.

The following table gives information in reference to the labor employed in the sandstone industry. It is evident that the highest wages are paid in the western states. This statement, of course, is true not only for this industry, but for others generally. In Ohio and Pennsylvania wages are not greatly different, although in Pennsylvania they are, as a rule, a little higher than in Ohio.

It will also be noticed that the total wages reported in the table on page as actually 648 paid do not exactly agree with the figures which would result from computing the total wages from the data given in the following table. This is very naturally the case, since the figures of the latter table are the averages given by the producers in response to an inquiry calling for average statements. The figures given for total wages actually paid are exact.

LABOR AND WAGES INVOLVED IN PRODUCTION OF SANDSTONE CLASSIFIED, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | FOREMEN. | | | | QUARRYMEN. | | | | MECHANICS AND STONECUTTERS. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number. | Average daily wages. | Average number of days. | Average yearly earnings. | Average number. | Average daily wages. | Average number of days. | Average yearly earnings. | Average number. | Average daily wages. | Average number of days. | Average yearly earnings. |
| Alabama | 5 | $2.48 | 254 | $629.92 | 53 | $1.06 | 239 | $253.34 | 9 | $3.50 | 230 | $805.00 |
| Arizona | 1 | 3.00 | 150 | 450.00 | 10 | 1.84 | 89 | 163.76 | | | | |
| Arkansas | 3 | 2.38 | 218 | 518.84 | 24 | 1.44 | 185 | 266.40 | 9 | 1.87 | 94 | 175.78 |
| California | 10 | 4.05 | 231 | 935.55 | 114 | 2.42 | 223 | 539.66 | 31 | 3.92 | 237 | 929.04 |
| Colorado | 90 | 3.09 | 208 | 642.72 | 854 | 2.35 | 216 | 507.60 | 187 | 2.45 | 236 | 578.20 |
| Connecticut | 45 | 2.98 | 249 | 742.02 | 814 | 1.87 | 249 | 465.63 | 58 | 2.80 | 232 | 649.60 |
| Idaho | | | | | 3 | 2.00 | 247 | 494.00 | | | | |
| Illinois | 4 | 2.56 | 175 | 448.00 | 33 | 1.67 | 116 | 193.72 | 1 | 2.15 | 36 | 77.40 |
| Indiana | 12 | 4.00 | 280 | 1,120.00 | 71 | 1.49 | 175 | 260.75 | 25 | 1.75 | 280 | 490.00 |
| Iowa | 8 | 3.30 | 191 | 630.30 | 41 | 2.20 | 160 | 352.00 | 21 | 2.43 | 210 | 510.30 |
| Kansas | 11 | 2.72 | 190 | 516.80 | 159 | 1.87 | 216 | 403.92 | 57 | 2.02 | 231 | 466.62 |
| Kentucky | 15 | 3.06 | 164 | 501.84 | 126 | 1.61 | 107 | 172.27 | 43 | 3.15 | 157 | 494.55 |
| Maryland | 2 | 1.50 | 170 | 255.00 | 39 | 1.14 | 158 | 180.12 | | | | |
| Massachusetts | 28 | 3.02 | 267 | 806.34 | 358 | 2.00 | 209 | 418.00 | 161 | 3.06 | 221 | 676.26 |
| Michigan | 9 | 2.92 | 255 | 744.60 | 132 | 1.68 | 171 | 287.28 | 31 | 2.63 | 232 | 610.16 |
| Minnesota | 10 | 3.00 | 235 | 705.00 | 151 | 1.53 | 231 | 353.43 | 16 | 2.00 | 260 | 520.00 |
| Missouri | 12 | 2.88 | 214 | 616.32 | 80 | 2.00 | 182 | 364.00 | 17 | 2.33 | 218 | 507.94 |
| Montana | 6 | 4.55 | 138 | 627.90 | 57 | 2.66 | 149 | 396.34 | 1 | 3.00 | 30 | 90.00 |
| New Hampshire | 2 | 3.80 | 174 | 661.20 | 9 | 1.49 | 119 | 177.31 | 1 | 1.50 | 130 | 195.00 |
| New Jersey | 38 | 3.00 | 268 | 804.00 | 290 | 2.03 | 246 | 499.38 | 130 | 3.20 | 241 | 771.20 |
| New Mexico | 11 | 4.08 | 120 | 489.60 | 217 | 2.26 | 96 | 216.96 | 47 | 3.30 | 116 | 382.80 |
| New York | 58 | 2.79 | 170 | 474.30 | 568 | 1.99 | 161 | 320.39 | 183 | 2.96 | 165 | 488.40 |
| North Carolina | 1 | 4.00 | 200 | 800.00 | 4 | 1.50 | 200 | 300.00 | 2 | 1.50 | 200 | 300.00 |
| Ohio | 187 | 2.59 | 222 | 574.98 | 1,660 | 1.73 | 204 | 352.92 | 506 | 2.06 | 231 | 475.86 |
| Oregon | | | | | 5 | 2.00 | 300 | 600.00 | | | | |
| Pennsylvania | 140 | 2.67 | 201 | 536.67 | 1,262 | 1.83 | 194 | 355.02 | 337 | 2.66 | 175 | 465.50 |
| South Dakota | 9 | 3.98 | 197 | 784.06 | 64 | 2.05 | 101 | 207.05 | 18 | 2.91 | 136 | 395.76 |
| Tennessee | 2 | 1.83 | 45 | 82.35 | 22 | 1.08 | 45 | 48.60 | 2 | 1.50 | 30 | 45.00 |
| Texas | 3 | 2.29 | 215 | 492.35 | 16 | 1.74 | 76 | 132.24 | 4 | 1.76 | 138 | 242.88 |
| Utah | 6 | 4.09 | 219 | 895.71 | 28 | 2.93 | 182 | 533.26 | 1 | 3.00 | 119 | 357.00 |
| Virginia | 3 | 2.72 | 145 | 394.40 | 20 | 1.00 | 146 | 146.00 | 5 | 2.50 | 120 | 300.00 |
| Washington | 6 | 3.57 | 262 | 935.34 | 57 | 2.28 | 157 | 357.96 | 10 | 3.16 | 153 | 483.48 |
| West Virginia | 23 | 2.51 | 149 | 373.99 | 136 | 1.44 | 154 | 221.76 | 28 | 2.73 | 145 | 395.85 |
| Wisconsin | 15 | 3.10 | 174 | 539.40 | 199 | 1.92 | 144 | 276.48 | 39 | 2.91 | 167 | 485.97 |
| Wyoming | 5 | 3.63 | 120 | 435.60 | 32 | 2.85 | 142 | 404.70 | 1 | 3.00 | 175 | 525.00 |
| Other states (*a*) | 2 | 2.00 | 138 | 276.00 | 29 | 1.37 | 134 | 183.58 | 2 | 1.50 | 175 | 262.50 |

*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Florida, Georgia, Nevada, Rhode Island, and Vermont.

LABOR AND WAGES INVOLVED IN PRODUCTION OF SANDSTONE CLASSIFIED, BY STATES AND TERRITORIES—Continued.

| STATES AND TERRITORIES. | LABORERS. | | | | BOYS UNDER 16 YEARS. | | | | OFFICE FORCE. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Average number. | Average daily wages. | Average number of days. | Average yearly earnings. | Average number. | Average daily wages. | Average number of days. | Average yearly earnings. | Average number. | Average annual salary. |
| Alabama | 54 | $1.16 | 242 | $280.72 | 5 | $0.59 | 237 | $139.83 | 1 | $480.00 |
| Arizona | 2 | 1.50 | 150 | 225.00 | | | | | | |
| Arkansas | 14 | 1.22 | 149 | 181.78 | | | | | | |
| California | 64 | 2.05 | 229 | 469.45 | 2 | 1.00 | 250 | 250.00 | 1 | 1,200.00 |
| Colorado | 313 | 2.01 | 238 | 478.38 | 8 | 1.24 | 119 | 147.56 | 33 | 725.00 |
| Connecticut | 150 | 1.74 | 238 | 414.12 | 5 | 0.85 | 280 | 238.00 | 20 | 2,006.88 |
| Idaho | 2 | 2.00 | 208 | 416.00 | | | | | | |
| Illinois | 8 | 1.38 | 60 | 82.80 | | | | | | |
| Indiana | 67 | 1.25 | 263 | 328.75 | 11 | 0.73 | 186 | 135.78 | 2 | 180.00 |
| Iowa | 63 | 1.48 | 209 | 309.32 | 3 | 0.51 | 146 | 74.46 | 6 | 1,250.00 |
| Kansas | 88 | 1.43 | 218 | 311.74 | 4 | 0.75 | 300 | 225.00 | 10 | 744.44 |
| Kentucky | 105 | 1.28 | 157 | 200.96 | 11 | 0.63 | 108 | 68.04 | 2 | 105.88 |
| Maryland | | | | | 2 | 0.57 | 175 | 99.75 | | |
| Massachusetts | 347 | 1.70 | 211 | 358.70 | 2 | 0.60 | 150 | 90.00 | 10 | 852.84 |
| Michigan | 166 | 1.46 | 243 | 354.78 | 5 | 1.00 | 145 | 145.00 | 2 | 800.00 |
| Minnesota | 22 | 1.55 | 300 | 465.00 | 5 | 1.00 | 260 | 260.00 | 1 | 800.00 |
| Missouri | 77 | 1.38 | 190 | 262.20 | 3 | 0.75 | 257 | 192.75 | 3 | 1,000.00 |
| Montana | 2 | 1.50 | 100 | 150.00 | 2 | 1.75 | 300 | 525.00 | 1 | 55.00 |
| New Hampshire | | | | | 1 | 0.50 | 35 | 17.50 | | |
| New Jersey | 378 | 1.45 | 251 | 363.95 | 11 | 0.94 | 231 | 217.14 | 10 | 480.74 |
| New Mexico | 87 | 1.79 | 56 | 100.24 | 11 | 0.75 | 45 | 33.75 | 4 | 393.33 |
| New York | 738 | 1.52 | 173 | 262.96 | 10 | 0.73 | 136 | 99.28 | 12 | 762.50 |
| North Carolina | 40 | 1.00 | 200 | 200.00 | 5 | 0.50 | 200 | 100.00 | 1 | 500.00 |
| Ohio | 1,610 | 1.33 | 182 | 242.06 | 54 | 0.74 | 198 | 146.52 | 78 | 1,157.24 |
| Oregon | 2 | 1.00 | 300 | 300.00 | | | | | | |
| Pennsylvania | 1,102 | 1.41 | 181 | 255.21 | 66 | 0.89 | 199 | 177.11 | 25 | 629.62 |
| South Dakota | 43 | 1.96 | 118 | 231.28 | | | | | 6 | 472.50 |
| Tennessee | 4 | 0.60 | 30 | 18.00 | | | | | 2 | 75.00 |
| Texas | 19 | 1.20 | 192 | 230.40 | | | | | | |
| Utah | 25 | 2.23 | 232 | 517.36 | | | | | 1 | 300.00 |
| Virginia | 8 | 1.00 | 130 | 130.00 | 1 | 0.75 | 130 | 97.50 | | |
| Washington | 29 | 2.08 | 200 | 416.00 | 1 | 0.75 | 50 | 37.50 | 2 | 1,033.33 |
| West Virginia | 133 | 1.24 | 144 | 178.56 | 13 | 0.73 | 153 | 111.69 | 4 | 445.50 |
| Wisconsin | 103 | 1.71 | 145 | 247.95 | 5 | 0.90 | 217 | 195.30 | 12 | 977.78 |
| Wyoming | 28 | 2.02 | 133 | 268.66 | | | | | 1 | 800.00 |
| Other states (*a*) | 19 | 1.41 | 147 | 207.27 | 1 | 1.00 | 175 | 175.00 | 2 | 450.00 |

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*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Florida Georgia, Nevada, Rhode Island, and Vermont.

The table following gives the states and territories in the order of their relative importance with respect to a number of different statistical items. It will be noticed that for all of these items except the number of cubic feet Ohio stands first, while Pennsylvania stands first in the number of cubic feet quarried. Inspection of this table will reveal at once a number of interesting features, which would require no little time and labor to extract from the principal table relative to production, in which all these items are contained. The most important of these items in determining the relative standing of the states is, of course, the value of the output.

### RELATIVE STANDING OF STATES AND TERRITORIES PRODUCING SANDSTONE ACCORDING TO VARIOUS STATISTICAL ITEMS.

| States and territories. | Cubic feet. | States and territories. | Value of product. | States and territories. | Capital in land. | States and territories. | Total capital. |
|---|---|---|---|---|---|---|---|
| Total | 71, 571, 054 | Total | $10, 816, 057 | Total | $11, 501, 100 | Total | $17, 776, 467 |
| 1 Pennsylvania | 17, 414, 875 | Ohio | 3, 046, 656 | Ohio | 3, 455, 499 | Ohio | 5, 075, 660 |
| 2 Ohio | 16, 016, 258 | Pennsylvania | 1, 609, 159 | Colorado | 1, 507, 255 | Colorado | 2, 009, 484 |
| 3 Colorado | 6, 570, 529 | Colorado | 1, 224, 098 | Connecticut | 1, 190, 606 | Pennsylvania | 1, 927, 410 |
| 4 New Jersey | 6, 010, 212 | Connecticut | 920, 061 | Pennsylvania | 1, 081, 894 | Connecticut | 1, 896, 957 |
| 5 New York | 4, 878, 365 | New York | 702, 419 | New York | 567, 880 | New York | 879, 380 |
| 6 Minnesota | 4, 156, 224 | Massachusetts | 649, 097 | New Jersey | 488, 650 | New Jersey | 793, 115 |
| 7 Connecticut | 2, 821, 430 | New Jersey | 597, 309 | New Mexico | 366, 400 | Michigan | 609, 877 |
| 8 Massachusetts | 1, 967, 179 | Michigan | 246, 570 | Minnesota | 328, 000 | Wisconsin | 550, 822 |
| 9 Wisconsin | 1, 146, 736 | New Mexico | 186, 804 | Wisconsin | 319, 615 | New Mexico | 421, 500 |
| 10 West Virginia | 964, 263 | Wisconsin | 183, 958 | California | 278, 000 | Minnesota | 407, 090 |
| 11 Kentucky | 888, 738 | California | 175, 598 | South Dakota | 240, 300 | California | 400, 950 |
| 12 Missouri | 734, 370 | Missouri | 155, 557 | Michigan | 215, 402 | Massachusetts | 373, 862 |
| 13 Kansas | 680, 289 | Kansas | 149, 289 | Missouri | 201, 100 | Kansas | 324, 135 |
| 14 Michigan | 658, 318 | West Virginia | 140, 687 | Kansas | 194, 510 | South Dakota | 303, 770 |
| 15 Montana | 644, 740 | Minnesota | 131, 979 | Massachusetts | 130, 550 | Missouri | 298, 380 |
| 16 Alabama | 610, 026 | Kentucky | 117, 940 | Wyoming | 130, 048 | Kentucky | 196, 580 |
| 17 New Mexico | 588, 048 | South Dakota | 93, 570 | West Virginia | 114, 478 | West Virginia | 181, 158 |
| 18 Washington | 540, 039 | Iowa | 80, 251 | Indiana | 113, 700 | Iowa | 178, 455 |
| 19 Maryland | 508, 325 | Washington | 75, 936 | Kentucky | 90, 468 | Indiana | 169, 225 |
| 20 Iowa | 404, 350 | Utah | 48, 306 | Iowa | 86, 870 | Wyoming | 139, 348 |
| 21 South Dakota | 341, 875 | Indiana | 43, 983 | Utah | 81, 125 | Utah | 123, 575 |
| 22 Indiana | 334, 441 | Alabama | 43, 965 | Oregon | 50, 000 | Washington | 78, 700 |
| 23 California | 333, 209 | Montana | 31, 648 | Montana | 46, 300 | Montana | 70, 400 |
| 24 Arkansas | 210, 010 | Arkansas | 25, 074 | North Carolina | 40, 000 | North Carolina | 70, 000 |
| 25 Wyoming | 197, 775 | Illinois | 17, 896 | Illinois | 33, 450 | Oregon | 53, 000 |
| 26 Texas | 180, 591 | Wyoming | 16, 760 | Washington | 30, 000 | Illinois | 49, 400 |
| 27 Utah | 145, 726 | Texas | 14, 651 | Maryland | 27, 480 | Maryland | 41, 000 |
| 28 Illinois | 141, 605 | North Carolina | 12, 000 | Arizona | 19, 400 | Arizona | 35, 000 |
| 29 Arizona | 127, 907 | Virginia | 11, 500 | New Hampshire | 15, 300 | New Hampshire | 22, 310 |
| 30 Virginia | 70, 800 | Maryland | 10, 605 | Texas | 10, 650 | Alabama | 18, 535 |
| 31 Tennessee | 53, 978 | Arizona | 9, 146 | Arkansas | 9, 750 | Arkansas | 17, 660 |
| 32 North Carolina | 50, 000 | Oregon | 8, 424 | Alabama | 8, 000 | Tennessee | 12, 988 |
| 33 Oregon | 50, 000 | New Hampshire | 3, 750 | Tennessee | 7, 520 | Texas | 12, 185 |
| 34 Idaho | 28, 710 | Tennessee | 2, 722 | Idaho | 6, 200 | Idaho | 10, 250 |
| 35 New Hampshire | 21, 665 | Idaho | 2, 490 | Virginia | 4, 700 | Virginia | 9, 180 |
| Other states (*a*) | 1, 079, 448 | Other states | 26, 199 | Other states | 10, 000 | Other states | 15, 126 |

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*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Florida, Georgia, Nevada, Rhode Island, and Vermont.

RELATIVE STANDING OF STATES AND TERRITORIES PRODUCING SANDSTONE, ETC.—Continued.

| States and territories. | Number of employés. | States and territories. | Wages paid. | States and territories. | Cost of supplies. | States and territories. | Total expenses. |
|---|---|---|---|---|---|---|---|
| Total | 16, 925 | Total | $6, 257, 580 | Total | $1, 277, 004 | Total | $8, 130, 295 |
| 1 Ohio | 4, 095 | Ohio | 1, 450, 266 | Ohio | 585, 635 | Ohio | 2, 277, 735 |
| 2 Pennsylvania | 2, 932 | Pennsylvania | 943, 641 | Pennsylvania | 143, 174 | Pennsylvania | 1, 180, 324 |
| 3 New York | 1, 569 | Colorado | 772, 158 | Connecticut | 127, 402 | Colorado | 902, 768 |
| 4 Colorado | 1, 485 | Connecticut | 528, 089 | Colorado | 76, 831 | Connecticut | 710, 772 |
| 5 Connecticut | 1, 092 | New York | 522, 702 | Massachusetts | 51, 051 | New York | 571, 381 |
| 6 Massachusetts | 906 | Massachusetts | 414, 282 | New Jersey | 48, 012 | Massachusetts | 509, 649 |
| 7 New Jersey | 866 | New Jersey | 380, 767 | New York | 39, 017 | New Jersey | 452, 657 |
| 8 New Mexico | 377 | California | 122, 847 | Minnesota | 23, 301 | California | 147, 264 |
| 9 Wisconsin | 373 | New Mexico | 122, 730 | Wisconsin | 19, 724 | New Mexico | 139, 309 |
| 10 Michigan | 345 | Wisconsin | 110, 509 | South Dakota | 19, 075 | Wisconsin | 138, 543 |
| 11 West Virginia | 337 | Kansas | 105, 507 | California | 16, 729 | Michigan | 127, 962 |
| 12 Kansas | 329 | Michigan | 102, 094 | New Mexico | 14, 750 | Kansas | 117, 594 |
| 13 Kentucky | 302 | Minnesota | 74, 110 | Kentucky | 14, 223 | Minnesota | 103, 107 |
| 14 California | 222 | West Virginia | 72, 269 | Michigan | 11, 529 | South Dakota | 90, 213 |
| 15 Minnesota | 205 | Missouri | 69, 549 | Iowa | 11, 387 | Kentucky | 86, 102 |
| 16 Missouri | 192 | South Dakota | 65, 434 | Utah | 10, 470 | Missouri | 81, 773 |
| 17 Indiana | 188 | Kentucky | 62, 745 | Kansas | 8, 855 | West Virginia | 80, 704 |
| 18 Iowa | 142 | Iowa | 56, 714 | Missouri | 8, 806 | Iowa | 71, 014 |
| 19 South Dakota | 140 | Washington | 45, 722 | Washington | 8, 650 | Washington | 54, 955 |
| 20 Alabama | 127 | Alabama | 41, 562 | West Virginia | 6, 037 | Alabama | 48, 587 |
| 21 Washington | 105 | Indiana | 37, 387 | Alabama | 5, 600 | Utah | 44, 321 |
| 22 Montana | 69 | Utah | 33, 598 | Indiana | 4, 663 | Indiana | 43, 232 |
| 23 Wyoming | 69 | Montana | 27, 881 | Wyoming | 3, 950 | Montana | 31, 454 |
| 24 Utah | 61 | Wyoming | 18, 283 | Montana | 3, 473 | Wyoming | 22, 871 |
| 25 North Carolina | 53 | Arkansas | 11, 287 | North Carolina | 2, 000 | Arkansas | 12, 860 |
| 26 Arkansas | 50 | Texas | 8, 993 | Texas | 1, 855 | Texas | 11, 520 |
| 27 Illinois | 46 | Illinois | 8, 937 | Arizona | 1, 200 | Illinois | 10, 898 |
| 28 Maryland | 43 | Virginia | 8, 000 | Arkansas | 1, 122 | North Carolina | 9, 600 |
| 29 Texas | 42 | Maryland | 7, 749 | Illinois | 977 | Maryland | 9, 271 |
| 30 Virginia | 37 | North Carolina | 7, 500 | Virginia | 570 | Virginia | 8, 629 |
| 31 Tennessee | 33 | Oregon | 3, 600 | Oregon | 500 | Oregon | 4, 400 |
| 32 Arizona | 13 | New Hampshire | 3, 138 | Maryland | 410 | Arizona | 3, 742 |
| 33 New Hampshire | 13 | Arizona | 2, 542 | New Hampshire | 403 | New Hampshire | 3, 621 |
| 34 Oregon | 7 | Tennessee | 2, 119 | Tennessee | 182 | Tennessee | 2, 603 |
| 35 Idaho | 5 | Idaho | 1, 350 | Idaho | 75 | Idaho | 1, 940 |
| Other states (*a*) | 55 | Other states | 11, 519 | Other states | 5, 366 | Other states | 17, 010 |

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*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Florida, Georgia, Nevada, Rhode Island, and Vermont.

The following table gives a number of deductions from the figures in the table on production, such as the percentages of the profit on capital, also on sales in the different states. It will be noticed that in 2 of the states loss is reported, but in these cases operations have been quite limited and only recently begun.

GENERAL STATISTICS.

| STATES AND TERRITORIES. | Total number of cubic feet. | Total value of product. | Total wages. | Total expense. | Total capital. | PERCENTAGE OF PROFIT ON— | | Cost per cubic foot of production. | Percentage of wages to total expense. | Amount of wages paid per cubic foot. | Percentage of wages to total value. | Value per cubic foot. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Capital. | Value of product. | | | | | |
| Total | 71, 571, 054 | $10, 816, 057 | $6, 257, 580 | $8, 130, 295 | $17, 776, 467 | 15. 11 | 24. 83 | $0. 11 | 76. 97 | $0. 09 | 57. 85 | $0. 15 |
| Alabama | 610, 026 | 43, 965 | 41, 562 | 48, 587 | 18, 535 | —24. 94 | —10. 51 | 0. 08 | 85. 54 | 0. 07 | 94. 53 | 0. 07 |
| Arizona | 127, 907 | 9, 146 | 2, 542 | 3, 742 | 35, 000 | 15. 44 | 59. 09 | 0. 03 | 67. 93 | 0. 02 | 27. 79 | 0. 07 |
| Arkansas | 210, 010 | 25, 074 | 11, 287 | 12, 860 | 17, 660 | 69. 16 | 48. 71 | 0. 06 | 87. 77 | 0. 05 | 45. 01 | 0. 12 |
| California | 333, 209 | 175, 598 | 122, 847 | 147, 264 | 400, 950 | 7. 07 | 16. 14 | 0. 44 | 83. 42 | 0. 37 | 69. 96 | 0. 53 |
| Colorado | 6, 570, 529 | 1, 224, 098 | 772, 158 | 902, 768 | 2, 009, 484 | 15. 99 | 26. 25 | 0. 14 | 85. 53 | 0. 12 | 63. 08 | 0. 19 |
| Connecticut | 2, 821, 430 | 920, 061 | 528, 089 | 710, 772 | 1, 896, 957 | 11. 03 | 22. 75 | 0. 25 | 74. 30 | 0. 19 | 57. 40 | 0. 33 |
| Idaho | 28, 710 | 2, 490 | 1, 350 | 1, 949 | 10, 250 | 5. 37 | 22. 09 | 0. 07 | 69. 59 | 0. 05 | 54. 22 | 0. 09 |
| Illinois | 141, 605 | 17, 896 | 8, 937 | 10, 808 | 49, 400 | 14. 35 | 39. 61 | 0. 08 | 82. 69 | 0. 06 | 49. 94 | 0. 13 |
| Indiana | 334, 441 | 43, 983 | 37, 387 | 43, 232 | 169, 225 | 0. 44 | 1. 71 | 0. 13 | 86. 48 | 0. 11 | 85. 00 | 0. 13 |
| Iowa | 404, 350 | 80, 251 | 56, 714 | 71, 014 | 178, 455 | 5. 18 | 11. 51 | 0. 18 | 79. 86 | 0. 14 | 70. 67 | 0. 20 |
| Kansas | 680, 289 | 149, 289 | 105, 507 | 117, 594 | 324, 135 | 9. 78 | 21. 23 | 0. 17 | 89. 72 | 0. 16 | 70. 67 | 0. 22 |
| Kentucky | 888, 738 | 117, 940 | 62, 745 | 86, 102 | 196, 580 | 16. 20 | 27. 00 | 0. 10 | 72. 87 | 0. 07 | 53. 20 | 0. 13 |
| Maryland | 508, 325 | 10, 605 | 7, 749 | 9, 271 | 41, 000 | 3. 25 | 12. 58 | 0. 02 | 83. 58 | 0. 02 | 73. 07 | 0. 02 |
| Massachusetts | 1, 967, 179 | 649, 097 | 414, 282 | 509, 649 | 373, 862 | 37. 30 | 21. 48 | 0. 26 | 81. 29 | 0. 21 | 63. 82 | 0. 33 |
| Michigan | 658, 318 | 246, 570 | 102, 094 | 127, 962 | 609, 877 | 19. 45 | 48. 10 | 0. 19 | 79. 78 | 0. 16 | 41. 41 | 0. 37 |
| Minnesota | 4, 156, 224 | 131, 979 | 74, 110 | 103, 107 | 407, 090 | 7. 09 | 21. 88 | 0. 02 | 71. 88 | 0. 02 | 56. 15 | 0. 03 |
| Missouri | 734, 370 | 155, 557 | 69, 549 | 81, 773 | 298, 380 | 24. 73 | 47. 43 | 0. 11 | 85. 05 | 0. 09 | 44. 71 | 0. 21 |
| Montana | 644, 740 | 31, 648 | 27, 881 | 31, 454 | 70, 400 | 0. 28 | 0. 61 | 0. 05 | 88. 64 | 0. 04 | 88. 10 | 0. 05 |
| New Hampshire | 21, 665 | 3, 750 | 3, 138 | 3, 621 | 22, 310 | 0. 58 | 3. 44 | 0. 17 | 86. 66 | 0. 14 | 83. 68 | 0. 17 |
| New Jersey | 6, 010, 212 | 597, 309 | 380, 767 | 452, 657 | 793, 115 | 18. 24 | 24. 22 | 0. 08 | 84. 12 | 0. 06 | 63. 75 | 0. 10 |
| New Mexico | 588, 048 | 186, 804 | 122, 730 | 139, 309 | 421, 500 | 11. 27 | 25. 43 | 0. 24 | 88. 10 | 0. 21 | 65. 70 | 0. 32 |
| New York | 4, 878, 365 | 702, 419 | 522, 702 | 571, 381 | 879, 380 | 14. 90 | 18. 66 | 0. 12 | 91. 48 | 0. 11 | 74. 41 | 0. 14 |
| North Carolina | 50, 000 | 12, 000 | 7, 500 | 9, 600 | 70, 000 | 3. 43 | 20. 00 | 0. 19 | 78. 13 | 0. 15 | 62. 50 | 0. 24 |
| Ohio | 16, 016, 258 | 3, 046, 656 | 1, 450, 266 | 2, 277, 735 | 5, 075, 660 | 15. 15 | 25. 24 | 0. 14 | 63. 67 | 0. 09 | 47. 60 | 0. 19 |
| Oregon | 50, 000 | 8, 424 | 3, 600 | 4, 400 | 53, 000 | 7. 59 | 47. 77 | 0. 09 | 81. 82 | 0. 07 | 42. 74 | 0. 17 |
| Pennsylvania | 17, 414, 875 | 1, 609, 159 | 943, 641 | 1, 180, 324 | 1, 927, 410 | 22. 25 | 26. 65 | 0. 07 | 79. 95 | 0. 05 | 58. 64 | 0. 09 |
| South Dakota | 341, 875 | 93, 570 | 65, 434 | 90, 213 | 303, 770 | 1. 11 | 3. 59 | 0. 26 | 72. 53 | 0. 19 | 69. 93 | 0. 27 |
| Tennessee | 53, 978 | 2, 722 | 2, 119 | 2, 603 | 12, 988 | 0. 92 | 4. 37 | 0. 05 | 81. 41 | 0. 04 | 77. 85 | 0. 05 |
| Texas | 180, 591 | 14, 651 | 8, 993 | 11, 520 | 12, 185 | 25. 70 | 21. 37 | 0. 06 | 78. 06 | 0. 05 | 61. 38 | 0. 08 |
| Utah | 145, 726 | 48, 306 | 33, 598 | 44, 321 | 123, 575 | 3. 22 | 8. 25 | 0. 30 | 75. 81 | 0. 23 | 69. 55 | 0. 33 |
| Virginia | 70, 800 | 11, 500 | 8, 000 | 8, 629 | 9, 180 | 31. 27 | 24. 97 | 0. 12 | 92. 71 | 0. 11 | 69. 57 | 0. 16 |
| Washington | 540, 039 | 75, 936 | 45, 722 | 54, 955 | 78, 700 | 26. 66 | 27. 63 | 0. 10 | 83. 20 | 0. 08 | 60. 21 | 0. 14 |
| West Virginia | 964, 263 | 140, 687 | 72, 269 | 80, 704 | 181, 158 | 33. 11 | 42. 64 | 0. 08 | 89. 55 | 0. 07 | 51. 37 | 0. 15 |
| Wisconsin | 1, 146, 736 | 183, 958 | 110, 509 | 138, 543 | 550, 822 | 8. 24 | 24. 69 | 0. 12 | 79. 77 | 0. 10 | 60. 07 | 0. 16 |
| Wyoming | 197, 775 | 16, 760 | 18, 283 | 22, 871 | 139, 348 | —4. 39 | —36. 46 | 0. 12 | 79. 94 | 0. 09 | 109. 09 | 0. 08 |
| Other states (*a*) | 1, 079, 448 | 26, 199 | 11, 519 | 17, 010 | 15, 126 | ........ | ........ | ........ | ........ | ........ | ........ | ........ |

*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Florida, Georgia, Nevada, Rhode Island, and Vermont.

## METHODS OF QUARRYING.

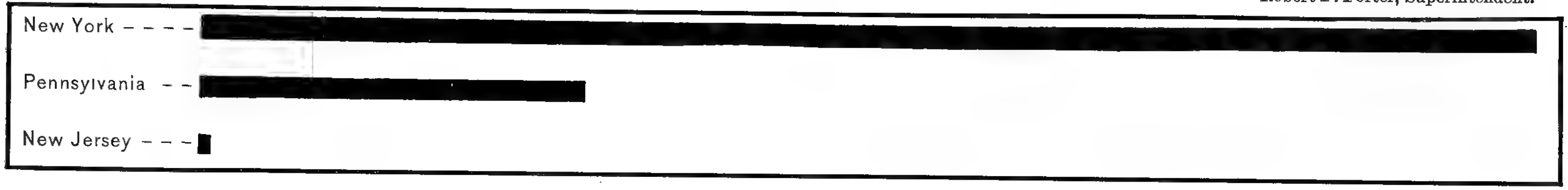
The work of quarrying sandstone is greatly facilitated by the ease with which parallel top and bottom beds may be obtained. In most cases good natural beds or partings parallel to the stratifications may be taken advantage of by the quarryman, and the rock is said to be thick bedded or thin bedded owing to the thickness of these sheets. The beds in the majority of quarries are horizontal or nearly so, and the object desired is to cut or break the sheets into rectangular blocks through to the bedding planes below. Much of this work was formerly accomplished by gunpowder used in the ordinary way or by heavy charges contained in tin canisters and exploded in specially large drill holes. These processes have been supplanted in the larger quarries by the Knox patent system of blasting rock and by the more extended use of steam channeling machines, such as are used in quarrying marble. The Knox system is particularly efficacious in thick-bedded sandstone, and the channelers are specially serviceable where the sheets are thinner. Vertical joints in the rock are a great aid in quarrying, and where they are numerous channelers are not required, and but little powder is necessary in loosening the blocks.

In some quarries the Knox system is used also in blocking up or subdividing the rock after the initial cuts have been made. Ordinarily, however, the plug-and-feather method is used, or in a rather soft variety, like the Connecticut brownstone, grooves are cut with pickaxes and the stone is broken by driving iron wedges into the grooves thus formed.

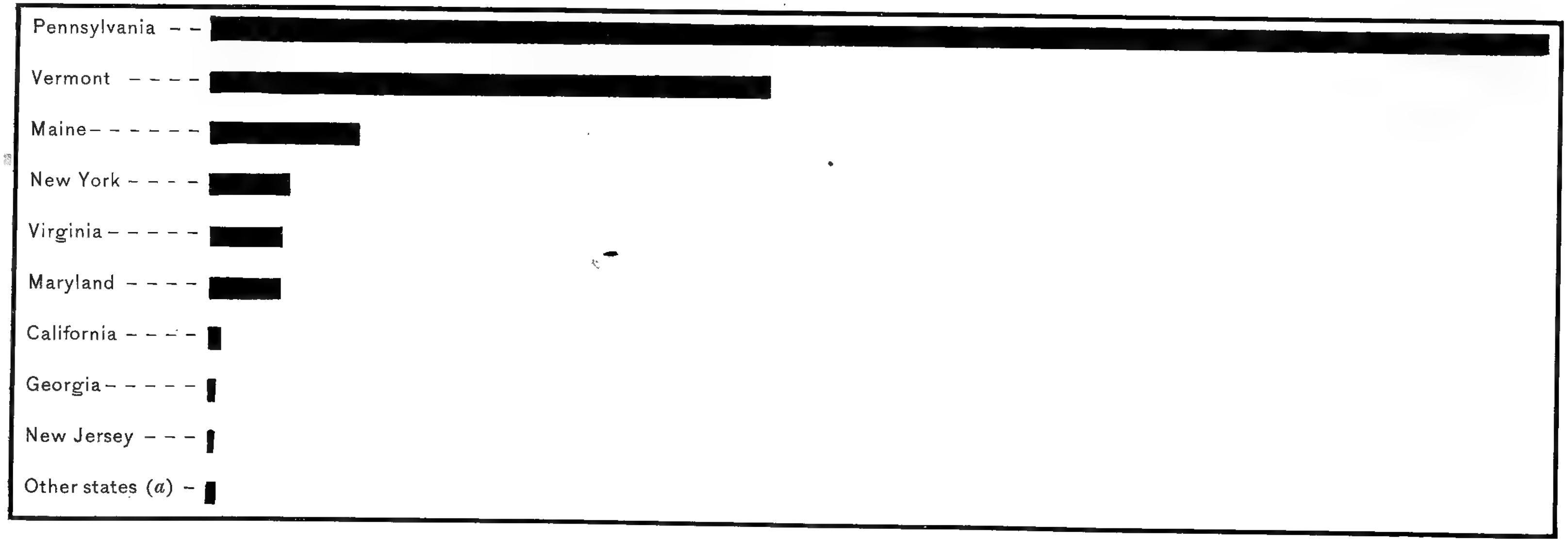
The following is a list of prominent structures built of sandstone in some of the principal cities of the United States:

PROMINENT SANDSTONE STRUCTURES IN SOME OF THE PRINCIPAL CITIES OF THE UNITED STATES.

| LOCALITY. | Name of structure and date of erection. | Commercial name of stone. | Locality of quarry. |
|---|---|---|---|
| Albany, New York | All Saints' cathedral | Potsdam sandstone | Potsdam, New York. |
| | Cathedral of the Immaculate Conception, 1852 | Brownstone | Portland, Connecticut. |
| | First Presbyterian church, 1884 | | East Longmeadow, Massachusetts. |
| | Albany academy, 1815 | Nyack sandstone | Nyack, New York. |
| Albuquerque, New Mexico | Territorial university (wing) | | Rio Puerco, New Mexico. |
| Baltimore, Maryland | First Presbyterian church | | New Brunswick, New Jersey. |
| | Mount Vernon Methodist Episcopal church | Berea sandstone | Berea, Ohio. |
| Boston, Massachusetts | Second Unitarian church | Red sandstone | Newark, New Jersey. |
| | New Old South church | Pudding stone | Roxbury, Massachusetts. |
| | Tremont street Methodist Episcopal church | Pudding stone | Boston, Massachusetts. |
| | Hotel Brunswick | Buff Amherst sandstone | Amherst, Ohio. |
| Brooklyn, New York | Saint Ann's Protestant Episcopal church | | ——, New Jersey. |
| | Academy of Design | Brownstone | Portland, Connecticut. |
| Carson City, Nevada | United States mint | Sandstone | Cañon City, Nevada. |
| Chicago, Illinois | Union League clubhouse | Brown sandstone | Springfield, Massachusetts. |
| | Palmer house | Buff Amherst sandstone | Amherst, Ohio. |
| | Public library | Berea sandstone | Berea, Ohio. |
| Cincinnati, Ohio | City hall | Brownstone | Houghton, Wisconsin. |
| Cleveland, Ohio | Garfield monument, Lake View cemetery | Berea sandstone | Berea, Ohio. |
| Colorado Springs, Colorado | First National Bank building | Peachblow sandstone | Peachblow, Colorado. |
| Columbus, Ohio | United States post office and courthouse | Berea sandstone | Berea, Ohio. |
| Denver, Colorado | Arapahoe county courthouse | | Cañon City, Colorado. |
| | Tabor grand opera house | Buff Amherst sandstone<br>Manitou sandstone | Amherst, Ohio.<br>Manitou, Colorado. |
| | Barclay block | Coal Creek sandstone | Coal Creek, Colorado. |
| Dover, Delaware | United States post office and courthouse | Berea sandstone | Berea, Ohio. |
| Grand Rapids, Michigan | City hall | Blue Amherst sandstone | Amherst, Ohio. |
| Lansing, Michigan | State capitol | Buff Amherst sandstone | Amherst, Ohio. |
| Leavenworth, Kansas | United States post office and courthouse | Blue Amherst sandstone | Amherst, Ohio. |
| Milwaukee, Wisconsin | Chamber of Commerce building | Blue Amherst sandstone | Amherst, Ohio. |
| Minneapolis, Minnesota | Westminster Presbyterian church, 1881–1883 | Brown sandstone | Fond du Lac, Minnesota. |
| | United States post office and courthouse | Blue Amherst sandstone | Amherst, Ohio. |
| Newark, New Jersey | Old customhouse and post office, 1859 | | Little Falls, New Jersey. |
| New York city | Columbia college | Red sandstone | Potsdam, New York. |
| | Trinity church, 1846 | | Little Falls, New Jersey. |
| | United Bank building | | East Longmeadow, Massachusetts. |
| | Broadway Bank building | | Portland, Connecticut. |
| | Collegiate Reformed church, 1872 | | Newark, New Jersey. |
| | Fulton National Bank building | | Hummelstown, Pennsylvania. |
| | Dutch Reformed church | Berea sandstone | Berea, Ohio. |
| | College of Surgeons | Buff Amherst sandstone | Amherst, Ohio. |
| Philadelphia, Pennsylvania | Saint Mark's Protestant Episcopal church, 1849 | Brownstone | Portland, Connecticut. |
| | Bank of North America, 1850 | Brownstone | Portland, Connecticut. |
| | Young Men's Christian Association building, 1868 | Buff Amherst sandstone | Amherst, Ohio. |
| Providence, Rhode Island | New Catholic cathedral | Brownstone | Portland, Connecticut. |
| | Grace church | | Little Falls, New Jersey. |
| Salt Lake City, Utah | Mormon tabernacle (piers) | Red sandstone | Red Butte, Utah. |
| San Francisco, California | Bank of California, 1865 | Blue sandstone | Angel Island, California. |
| Santa Fe, New Mexico | Federal building | Cerrillos sandstone | Los Cerrillos, New Mexico. |
| Trenton, New Jersey | State capitol | | Trenton, New Jersey. |
| Washington, District of Columbia | Smithsonian Institution, 1847–1856 | Seneca sandstone | Seneca creek, Maryland. |
| | United States capitol, old portion, 1793 | | Aquia creek, Virginia. |
| | Executive mansion (painted) | | Aquia creek, Virginia. |
| | Treasury, old portion, 1836–1841 | | Aquia creek, Virginia. |



RELATIVE RANK OF STATES PRODUCING BLUESTONE.



RELATIVE RANK OF STATES PRODUCING SLATE.

*a* Arkansas, Michigan, and Utah.

# BLUESTONE.

Bluestone is the name given to one of the varieties of sandstone. It consists of exceedingly small particles of silica cemented together by silica. Practically, the entire cementing material is silica, with the exception of a slight amount of argillaceous material, which is present to a very limited extent. Owing to the minuteness of the silica and the firmness of the siliceous cement the stone is extremely hard and durable, and naturally difficult to work. In the beginning of the investigation for the purpose of collecting stone statistics it was decided to include bluestone with sandstone simply as one of the varieties of the latter. This decision was, however, afterward changed, partly because the producers of bluestone are in a large number of cases apparently ignorant of the fact that bluestone is properly a sandstone, and it was found that a number of them object strenuously to the name sandstone. It was also found that, owing to the peculiarities of the methods of conducting bluestone quarrying and the subsequent disposal of the product, a separation of bluestone from sandstone was advisable, and even necessary, for reasons that will be given in detail.

Owing to the hardness and durability of this stone, as well as to the manner in which it occurs in the earth, it is well adapted for purposes of street paving, such as flagging and curbing, and most of it is devoted to these uses. The business methods involved in the operations of quarrying and putting the stone into the hands of the consumers are peculiar. A certain amount of the stone is quarried from regularly organized quarries, with a definitely invested capital and plant or facilities for quarrying. From all such quarries statistics were obtained by means of schedules, according to the method adopted for all other kinds of stone; but in addition to the stone taken from these regularly operated quarries a large amount is produced irregularly and spasmodically by men who invest no capital and have no definite organization as producers of stone. Their operations are conducted as follows: provided with a very simple equipment of the most ordinary quarry tools, they dislodge the stone found on land belonging to other persons and transport it to a number of shipping points, selling it there to dealers, who make a business of collecting stone in this manner and then shipping it to the place where used. The dealers pay the individuals who quarry the stone an amount which simply compensates the seller for his time and labor, while the owner of the property receives a certain definite percentage from the dealer for the amount of stone thus taken from his land. During the year 1889 and a number of years previous some of the dealers at various points in New York state constituted the members of the Union Bluestone Company, with headquarters in New York city. Each member of this company was entitled to furnish a certain percentage of the total amount sold by this company in a given year. The dealers may therefore be regarded in a certain sense as producers. From these considerations it becomes evident that it was impossible to obtain a knowledge of the value of the land from which stone was taken in this irregular manner, and also to obtain replies, which have been so readily secured from definitely organized companies operating quarries.

The table on page 660, giving statistics relative to the bluestone industry, exhibits returns from all regularly operated quarries, including replies to all inquiries which have been addressed to operators of regular quarries in all kinds of stone. A table on the same page includes the total purchases of these dealers from the laborers who obtain their output in the manner above described, and also from farmers. The irregular methods of conducting the bluestone industry are probably due in great part to the manner in which the stone occurs. Many of the ledges run out in a short time, and are then, of course, abandoned, so that long-continued operations at one point are not possible in many cases.

The tables show in as complete a manner as it was possible to make them the various statistics relative to the bluestone industry in the 3 states considered. The area from which bluestone is taken, and which is considered in this report, comprises the following counties in the states named:

NEW JERSEY.—Hunterdon, Mercer, and Sussex.

NEW YORK.—Albany, Broome, Cayuga, Chemung, Chenango, Delaware, Greene, Jefferson, Oneida, Orange, Otsego, Rockland, Saratoga, Schenectady, Schoharie, Schuyler, Seneca, Steuben, Sullivan, Tompkins, Ulster, Washington, Wyoming, and Yates.

PENNSYLVANIA.—Bradford, Lackawanna, Luzerne, Lycoming, Monroe, Pike, Schuylkill, Susquehanna, Wayne, and Wyoming.

The number of square miles embraced in this area is 26,897.

## TOTAL BLUESTONE PRODUCTION, INCLUDING PURCHASES BY WHOLESALE DEALERS.

| STATES. | Total. | | RETURNS FROM REGULARLY OPERATED QUARRIES. | | | | Purchases by wholesale dealers. | |
|---|---|---|---|---|---|---|---|---|
| | | | Rubble and bridge stone, sold by perch and cubic yard. | | Dimension stone. | | | |
| | Cubic feet. | Amount. | Cubic feet. | Amount. | Cubic feet. | Amount. | Cubic feet. | Amount. |
| Total | 5, 126, 340 | $1, 689, 606 | 1, 641, 626 | $53, 768 | 1, 518, 260 | $696, 144 | 1, 966, 454 | $939, 694 |
| New Jersey | 15, 649 | 8, 550 | | | 15, 649 | 8, 550 | | |
| New York | 4, 009, 942 | 1, 303, 321 | 1, 514, 767 | 51, 495 | 842, 957 | 423, 908 | 1, 652, 218 | 827, 918 |
| Pennsylvania | 1, 100, 749 | 377, 735 | 126, 859 | 2, 273 | 659, 654 | 263, 686 | 314, 236 | 111, 776 |

## STATISTICS OF BLUESTONE PRODUCED FROM SYSTEMATICALLY OPERATED QUARRIES ONLY.

| STATES. | Number of individuals or firms operating quarries. | Number of quarries operated. | PRODUCT. | | | | | LABOR. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Superficial feet. | Linear feet. | Cubic feet. | Total expressed in cubic feet. | Total value. | Total number employed. | Foremen. | Quarrymen. | Mechanics. | Laborers. | Boys under 16 years. | Office force. |
| Total | 211 | 217 | 4, 012, 817 | 882, 005 | 1, 861, 446 | 3, 159, 886 | $749, 912 | 1, 793 | 144 | 778 | 109 | 736 | 18 | 8 |
| New Jersey | 3 | 3 | 67, 000 | 4, 200 | | 15, 649 | 8, 550 | 34 | 3 | 13 | | 17 | 1 | |
| New York | 142 | 142 | 2, 241, 335 | 543, 985 | 1, 612, 041 | 2, 357, 724 | 475, 403 | 1, 113 | 94 | 484 | 78 | 436 | 14 | 7 |
| Pennsylvania | 66 | 72 | 1, 704, 482 | 333, 820 | 249, 405 | 786, 513 | 265, 959 | 646 | 47 | 281 | 31 | 283 | 3 | 1 |

| STATES. | POWER. | | | | EXPENSES. | | | | CAPITAL INVESTED. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number of boilers. | Total horse power of boilers. | Other power. | Number of animals employed. | Total expenses incurred in producing entire amount of bluestone. | Total wages, including salaries to office force. | Value of supplies and materials consumed. | All other expenditures for the quarries, such as rent, taxes, insurance, interest, etc. | Total capital. | In land. | In buildings and fixtures. | In tools, live stock, machinery, and supplies on hand. | In cash. |
| Total | 12 | 169 | | 183 | $608, 582 | $527, 634 | $34, 785 | $46, 163 | $635, 757 | $428, 380 | $17, 015 | $106, 292 | $84, 070 |
| New Jersey | | | | | 7, 122 | 6, 795 | 275 | 52 | 21, 850 | 9, 300 | 1, 550 | 1, 000 | 10, 000 |
| New York | 9 | 135 | | 145 | 395, 894 | 333, 574 | 26, 768 | 35, 552 | 409, 261 | 264, 980 | 10, 205 | 77, 506 | 56, 570 |
| Pennsylvania | 3 | 34 | | 38 | 205, 566 | 187, 265 | 7, 742 | 10, 559 | 204, 646 | 154, 100 | 5, 260 | 27, 786 | 17, 500 |

| STATES. | EMPLOYÉS. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Foremen. | | Qarrymen. | | Mechanics. | | Laborers. | | Boys under 16 years. | |
| | Average number of days employed. | Average daily wages. | Average number of days employed. | Average daily wages. | Average number of days employed. | Average daily wages. | Average number of days employed. | Average daily wages. | Average number of days employed. | Average daily wages. |
| Total | 162 | $2. 53 | 159 | $2. 02 | 135 | $2. 37 | 159 | $1. 44 | 146 | $0. 80 |
| New Jersey | 137 | 2. 20 | 90 | 2. 25 | | | 139 | 1. 35 | 90 | 0. 75 |
| New York | 159 | 2. 55 | 163 | 1. 95 | 129 | 2. 43 | 159 | 1. 48 | 156 | 0. 81 |
| Pennsylvania | 169 | 2. 51 | 154 | 2. 13 | 150 | 2. 23 | 161 | 1. 38 | 120 | 0. 75 |

Owing to the unique character of the bluestone industry, as indicated in the foregoing statements, it has been thought advisable to give a somewhat more detailed description of it than has been necessary in connection with the other kinds of stone, which are more or less distributed over the entire country. Much of this region is composed of rough mountain land, of little value except for the stone to be obtained from it. Over this region quarrymen, operating on the limited scale already indicated, are continually prospecting for such ledges of stone as will justify their labor, which is carried on with extremely simple implements, producing the stone principally in the form of flagging. Originally the stone was quarried for flagging only, but recently it has been applied to quite a long list of purposes, such as rubble masonry, retaining walls and bridge stone, sidewalks, crosswalks, curbing, gutters, flagging, stepstones, flooring, vault covers, bases of tombstones, porch and hitching posts, and house trimmings, such as platforms, steps, door and window sills, lintels, and caps.

Although the name of the stone implies that it is of a blue color, this is not invariably the case. The colors vary from dark-blue or slate color to bluish gray, and sometimes the stone presents a greenish tinge, and in other cases a brown. The stone is known commercially by several names, which designate, approximately, the region from which it is taken. Among the names in common use may be mentioned the following: Hudson River bluestone, Hudson River flagging, North River bluestone, North River flagging, Pennsylvania bluestone, Wyoming Valley bluestone, Delaware River bluestone, Delaware flags, bluestone flagging, and bluestone. The methods of transportation employed by bluestone quarrymen in getting their product from the quarries to the dealers necessitate the employment of a large number of teams, principally horses, although oxen are also employed in Pennsylvania. The principal shipping points for general distribution to which stone is transported directly from the quarries in New York state are Kingston (including Wilbur and Rondout), Malden, Saugerties, Catskill, and Coeymans, all along the Hudson river. Leading into Kingston are stone tramways, constructed over a distance of 9 miles, coming from quarries at West Hurley, and between other quarries and shipping points similar tramways are in use. These enable exceedingly heavy loads to be hauled. Ruts have been worn in the stone by the heavily-laden wagons, and these ruts answer the purpose of a track, from which it is impossible for the wheels to escape in the course of a trip.

## METHODS OF QUARRYING.

Bluestone occurs in beds, the surface layers of which are often quite thin. The thickness, however, increases with the depth, so that layers well below the surface are frequently of considerable thickness. In many quarries the stone is taken out with considerable ease by the very simplest tools and methods, so that in many cases powder is not used. When the stone exceeds 6 inches in thickness it is necessary to drill a row of plug holes and remove it by a series of wedges. In the quarries operated principally for flagging the blocks are simply pried out by iron or steel bars. The Knox system of blasting is in use at some of the principal quarries in New York state. Some quarries also operate mills, where the usual machinery, such as planers, saws, and rubbing beds, is operated. At some of these mills the facilities are very complete, but do not differ essentially from those in use in mills operating upon other kinds of stone.

## BUSINESS METHODS.

Owing to the fact that no carefully itemized accounts on the part of the dealers are kept and to the total absence of any records whatever on the part of the roving quarrymen, who operate here and there, the task of collecting the statistics of bluestone has been rendered one of exceeding difficulty, and, having never before been attempted with the completeness which has attended the present investigation, it was entirely pioneer work. The methods adopted necessarily vary according to the peculiarities of business methods in an individual locality.

The royalty paid by the shipping agent or dealer to the owner of the property varies from 0.5 to 1.5 cents per superficial foot. In some cases a percentage ranging from 5 to 10 per cent of the price received from the sale is charged by the owner of the land. The dealers keep no account of the number of feet or the total value of the stone obtained from any particular quarryman, nor do they keep a permanent record of the property from which a particular quarryman has secured the stone sold by him. Furthermore, the dealers keep a record of the stock purchased in various ways, generally measuring it in superficial feet without taking any account of the particular thickness, or in linear feet without noting either of the other dimensions beyond certain general limits which these dimensions do not exceed. In regard to the value of property from which bluestone is taken, it may be said that this is extremely variable, depending, as it does, entirely upon the quality and the amount of stone contained in it, as the land is worth very little for agricultural purposes. As soon as the supply of stone is exhausted the value of the property drops to the low figure at which it is valued as agricultural land.

# SLATE.

The total value of all slate produced in the United States in 1889, as shown by the following table, is $3,482,513. Of this amount $2,797,904 is the value of 835,625 squares of roofing slate, and $684,609 is the value of slate for all other purposes besides roofing.

As compared with the statements of the Tenth Census report of 1880 on stone, the roofing-slate product of 1889 is nearly twice as great in number of squares and in value. A consideration of the slate used for purposes other than roofing appears to have been omitted from the Tenth Census report. The total value of all slate produced in 1889 is more than twice as great as that considered in the Tenth Census.

According to Mineral Resources of the United States, 1888, the total number of squares of roofing slate produced in that year is 662,400, valued at $2,053,440.

## DISTRIBUTION OF THE QUARRIES.

At present 12 states produce slate. A line drawn on the map from Piscataquis county, Maine, to Polk county, Georgia, and approximately following the coast outline, passes through all the important slate-producing localities. According to amount and value of product the most important states are, in the order named, Pennsylvania, Vermont, Maine, New York, Maryland, and Virginia. In the remaining 6 states productive operations are of limited extent, and in the case of Arkansas, California, and Utah of very recent date.

Inasmuch as in slate quarrying the initial operations are those of stripping and excavating, preliminary to actual output, some time must necessarily elapse before any returns for labor can be realized.

The 12 states referred to do not include all those in which merchantable slate is known to exist, since discoveries promising good results for the future have been made in a number of other states, among which may be specially mentioned Tennessee, where operations for production have begun.

PRODUCTION OF SLATE IN THE UNITED STATES IN 1889, BY STATES.

| STATES. | Number of quarries operated in 1889. | PRODUCT. | | | | LABOR. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Average number of employés. | | | | | | |
| | | Number of squares of roofing slate. (*a*) | Total value of roofing slate. | Total value of slate for other purposes. | Total value of all slate produced. | Total number employed. | Foremen. | Quarrymen and millmen. | Mechanics. | Laborers. | Boys under 16 years. | Office force. |
| Total | 212 | 835, 625 | $2, 797, 904 | $684, 609 | $3, 482, 513 | 6, 170 | 221 | 3, 251 | 282 | 1, 986 | 355 | 75 |
| California | 3 | 3, 104 | 18, 089 | ... | 18, 089 | 45 | 3 | 18 | 5 | 15 | ... | 4 |
| Georgia | 4 | 3, 050 | 14, 850 | 480 | 15, 330 | 31 | 2 | 15 | ... | 12 | 2 | ... |
| Maine | 8 | 41, 000 | 201, 500 | 18, 000 | 219, 500 | 327 | 11 | 186 | 16 | 113 | ... | 1 |
| Maryland | 5 | 23, 099 | 105, 745 | 4, 263 | 110, 008 | 185 | 7 | 109 | 10 | 44 | 12 | 3 |
| New Jersey | 5 | 2, 700 | 9, 675 | 1, 250 | 10, 925 | 41 | 1 | 27 | ... | 12 | ... | 1 |
| New York | 15 | 16, 767 | 81, 726 | 44, 877 | 126, 603 | 206 | 13 | 148 | 2 | 37 | 2 | 4 |
| Pennsylvania | 105 | 476, 038 | 1, 641, 003 | 370, 723 | 2, 011, 726 | 3, 667 | 137 | 1, 764 | 204 | 1, 254 | 275 | 33 |
| Vermont | 61 | 236, 350 | 596, 997 | 245, 016 | 842, 013 | 1, 338 | 38 | 862 | 40 | 348 | 29 | 21 |
| Virginia | 3 | 30, 457 | 113, 079 | ... | 113, 079 | 294 | 7 | 119 | 2 | 124 | 35 | 7 |
| Other states (*b*) | 3 | 3, 060 | 15, 240 | ... | 15, 240 | 36 | 2 | 3 | 3 | 27 | ... | 1 |

| STATES. | EXPENSES. | | | | POWER. | | | | CAPITAL INVESTED. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total expenses of producing entire amount of slate. | Total wages, including salaries paid to office force. | Value of supplies and materials consumed. | All other expenditures for the quarries, such as rent, taxes, insurance, interest, etc. | Number of boilers. | Total horse power of boilers. | Horse power of water wheels. | Number of animals employed. | Total capital. | In land. | In buildings and fixtures. | In tools, live stock, machinery, and supplies on hand. | In cash. |
| Total | $2, 762, 122 | $2, 218, 982 | $282, 114 | $261, 026 | 291 | 11, 772 | 265 | 400 | $10, 569, 593 | $7, 408, 491 | $609, 038 | $1, 228, 738 | $1, 323, 326 |
| California | 44, 245 | 31, 085 | 5, 053 | 8, 107 | 1 | 8 | 20 | 3 | 85, 800 | 61, 200 | 4, 000 | 2, 800 | 17, 800 |
| Georgia | 13, 551 | 11, 371 | 830 | 1, 350 | 2 | 20 | ... | 6 | 155, 000 | 141, 150 | 1, 350 | 1, 500 | 11, 000 |
| Maine | 151, 090 | 125, 640 | 24, 500 | 950 | 15 | 810 | ... | 12 | 1, 141, 000 | 845, 000 | 144, 000 | 101, 000 | 51, 000 |
| Maryland | 85, 444 | 65, 255 | 10, 969 | 9, 220 | 12 | 557 | ... | 12 | 334, 000 | 219, 200 | 15, 350 | 46, 450 | 53, 000 |
| New Jersey | 9, 127 | 7, 367 | 1, 185 | 575 | 5 | 193 | ... | 9 | 103, 550 | 74, 150 | 11, 800 | 12, 300 | 5, 300 |
| New York | 98, 289 | 81, 797 | 9, 900 | 6, 592 | 15 | 349 | 140 | 30 | 287, 680 | 179, 200 | 20, 780 | 48, 900 | 38, 800 |
| Pennsylvania | 1, 631, 022 | 1, 283, 535 | 169, 788 | 177, 699 | 171 | 7, 941 | 65 | 218 | 6, 863, 002 | 5, 087, 507 | 268, 432 | 718, 373 | 788, 690 |
| Vermont | 616, 113 | 517, 257 | 48, 025 | 50, 831 | 65 | 1, 649 | 40 | 87 | 1, 299, 451 | 736, 900 | 80, 071 | 230, 265 | 252, 215 |
| Virginia | 95, 246 | 80, 920 | 11, 624 | 2, 702 | 4 | 170 | ... | 16 | 181, 500 | 37, 684 | 13, 095 | 26, 925 | 103, 796 |
| Other states (*b*) | 17, 995 | 14, 755 | 240 | 3, 000 | 1 | 75 | ... | 7 | 118, 610 | 26, 500 | 50, 160 | 40, 225 | 1, 725 |

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*a* A square is the number of slates it takes to cover 100 square feet of roof when properly laid.

*b* There are here grouped, in order that the business of individual establishments may not be disclosed to the public, Arkansas, Michigan, and Utah.

## PRODUCTION OF SLATE, BY REGIONS.

The table on the preceding page shows the geographical distribution of the quarries by states, but in order to conform to the custom observed by slate producers, the following table, in which the figures are arranged by regions, is also presented:

### PRODUCTION OF SLATE IN THE UNITED STATES IN 1889, BY REGIONS.

| REGIONS. | Number of quarries. | PRODUCT. | | | | LABOR. | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Number of squares of roofing slate. | Total value of roofing slate. | Total value of slate for other purposes. | Total value of all slate produced. | Average number of employés. | | | | | | |
| | | | | | | Total number employed. | Foremen. | Quarrymen and millmen. | Mechanics. | Laborers. | Boys under 16 years. | Office force. |
| Total | 212 | 835, 625 | $2. 797, 904 | $684, 609 | $3, 482, 513 | 6, 170 | 221 | 3, 251 | 282 | 1, 986 | 355 | 75 |
| California | 3 | 3. 104 | 18, 089 | .......... | 18, 089 | 45 | 3 | 18 | 5 | 15 | .......... | 4 |
| Maine | 8 | 41, 000 | 201, 500 | 18, 000 | 219, 500 | 327 | 11 | 186 | 16 | 113 | .......... | 1 |
| Peach Bottom region, comprising Harford county, Maryland, and York county, Pennsylvania. | 9 | 31, 067 | 142, 255 | 4, 310 | 146, 565 | 233 | 10 | 138 | 13 | 53 | 16 | 3 |
| New Jersey | 5 | 2, 700 | 9, 675 | 1, 250 | 10, 925 | 41 | 1 | 27 | .......... | 12 | .......... | 1 |
| Bangor region, Pennsylvania. | 20 | 165, 882 | 588, 258 | 118, 904 | 707, 162 | 1, 257 | 32 | 617 | 57 | 433 | 107 | 11 |
| Lehigh region, Pennsylvania. | 45 | 142, 500 | 478, 559 | 211, 823 | 690, 382 | 1, 219 | 63 | 553 | 79 | 427 | 85 | 12 |
| Northampton Hard Vein region, Pennsylvania. | 18 | 47, 074 | 163, 449 | 21, 146 | 184, 595 | 455 | 22 | 220 | 27 | 154 | 27 | 5 |
| Pen Argyl region, Pennsylvania. | 18 | 112, 614 | 374, 227 | 18, 803 | 393, 030 | 688 | 17 | 345 | 38 | 231 | 52 | 5 |
| Vermont and New York region, comprising Rutland county, Vermont, and Washington county, New York. (*a*) | 76 | 253, 117 | 678, 723 | 289, 893 | 968, 616 | 1, 544 | 51 | 1, 010 | 42 | 385 | 31 | 25 |
| Virginia | 3 | 30, 457 | 113, 079 | .......... | 113, 079 | 294 | 7 | 119 | 2 | 124 | 35 | 7 |
| Georgia | 4 | 3, 050 | 14, 850 | 480 | 15, 330 | 31 | 2 | 15 | .......... | 12 | 2 | .......... |
| Other states (*b*) | 3 | 3, 060 | 15, 240 | .......... | 15, 240 | 36 | 2 | 3 | 3 | 27 | .......... | 1 |

| REGIONS. | EXPENSES. | | | | POWER. | | | | CAPITAL INVESTED. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total expenses of producing entire amount of slate. | Total wages, including salaries paid to office force. | Value of supplies and materials consumed. | All other expenditures for the quarries, such as rent, taxes, insurance, interest, etc. | Number of boilers. | Total horse power of boilers. | Horse power of water wheels. | Number of animals employed. | Total capital. | In land. | In buildings and fixtures. | In tools, live stock, machinery, and supplies on hand. | In cash. |
| Total | $2, 762, 122 | $2, 218, 982 | $282, 114 | $261, 026 | 291 | 11, 772 | 265 | 400 | $10, 569, 593 | $7, 408, 491 | $609, 038 | $1, 228, 738 | $1, 323, 326 |
| California | 44, 245 | 31, 085 | 5, 053 | 8, 107 | 1 | 8 | 20 | 3 | 85, 800 | 61, 200 | 4, 000 | 2, 800 | 17, 800 |
| Maine | 151, 090 | 125, 640 | 24, 500 | 950 | 15 | 810 | ........ | 12 | 1, 141, 000 | 845, 000 | 144, 000 | 101, 000 | 51, 000 |
| Peach Bottom region, comprising Harford county, Maryland, and York county, Pennsylvania. | 105, 037 | 81, 066 | 12, 423 | 11, 548 | 16 | 712 | ........ | 16 | 458, 000 | 314, 145 | 17, 800 | 57, 340 | 68, 715 |
| New Jersey | 9, 127 | 7, 367 | 1, 185 | 575 | 5 | 193 | ........ | 9 | 103, 550 | 74, 150 | 11, 800 | 12, 300 | 5, 300 |
| Bangor region, Pennsylvania. | 555, 239 | 446, 272 | 54, 548 | 54, 419 | 44 | 2, 261 | ........ | 72 | 1, 888, 575 | 1, 431, 350 | 53, 200 | 208, 525 | 195, 500 |
| Lehigh region, Pennsylvania. | 508, 219 | 390, 578 | 61, 492 | 56, 149 | 64 | 2, 706 | 65 | 64 | 2, 352, 993 | 1, 628, 140 | 132, 507 | 314, 377 | 277, 969 |
| Northampton Hard Vein region, Pennsylvania. | 177, 695 | 143, 969 | 21, 349 | 12, 377 | 30 | 1, 229 | ........ | 38 | 972, 609 | 736, 679 | 52, 675 | 70, 441 | 112, 814 |
| Pen Argyl region, Pennsylvania. | 370, 276 | 286, 905 | 30, 945 | 52, 426 | 29 | 1, 590 | ........ | 40 | 1, 524, 825 | 1, 196, 393 | 27, 600 | 114, 140 | 186, 692 |
| Vermont and New York region, comprising Rutland county, Vermont, and Washington county, New York. (*a*) | 714, 402 | 599, 054 | 57, 925 | 57, 423 | 80 | 1, 998 | 180 | 117 | 1, 587, 131 | 916, 100 | 100, 851 | 279, 165 | 291, 015 |
| Virginia | 95, 246 | 80, 920 | 11, 624 | 2, 702 | 4 | 170 | ........ | 16 | 181, 500 | 37, 684 | 13, 095 | 26, 925 | 103, 796 |
| Georgia | 13, 551 | 11, 371 | 830 | 1, 350 | 2 | 20 | ........ | 6 | 155, 000 | 141, 150 | 1, 350 | 1, 500 | 11, 000 |
| Other states (*b*) | 17, 995 | 14, 755 | 240 | 3, 000 | 1 | 75 | ........ | 7 | 118, 610 | 26, 500 | 50, 160 | 40, 225 | 1, 725 |

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*a* Included in the production of this region are 7,247 squares of red slate, valued at $61,101, taken entirely from quarries in Washington county, New York, the only locality in the country producing red slate.

*b* There are here grouped, in order that the business of individual establishments may not be disclosed to the public, Arkansas, Michigan, and Utah

It will be observed that these regions do not coincide exactly with states, nor, in the case of the Lehigh region, with counties, but in a number of instances they overlap the geographical boundaries of state and county; thus the Peach Bottom region lies both in Maryland and Pennsylvania, and the Lehigh region in Lehigh, Carbon, and Berks counties and a small portion of Northampton county.

As shown in the table, the Bangor region, which is entirely within Northampton county, Pennsylvania, is the most important. This region includes quarries at Bangor, East Bangor, and Mount Bethel, Pennsylvania. (The character of the slate produced at Mount Bethel is similar to that of the Northampton Hard Vein region.) Included in the Lehigh region, besides Lehigh county, Pennsylvania, are a few quarries in Berks and Carbon counties and a small number in Northampton county, on the opposite side of the Lehigh river.

The Pen Argyl region embraces quarries at Pen Argyl and Wind Gap.

The Northampton Hard Vein region is specially distinguished on account of the extreme hardness of the slate as compared with that produced in other regions of the state. This region includes the following localities: Chapman's quarries, Belfast, Edelman, Seemsville, and Treichlers, all in Northampton county.

Of the 9 quarries included in the Peach Bottom region, 5 are in Harford county, Maryland, the remaining 4 being in York county, Pennsylvania.

The Vermont and New York region includes an extensive slate formation occupying a part of the old Champlain valley, lying between the western base of the Green mountains of Vermont and the southern trend of the Adirondacks, in New York. The area in which slate is actually produced at present is confined to a narrow strip in Washington county, New York, and a somewhat wider one lying next to it in Rutland county, Vermont. It extends from Castleton, Vermont, on the north, to Salem, New York, on the south, a distance of 35 or 40 miles, and has a maximum width of 6 miles, but the average is not more than 1½ miles. With the exception of red slate, the production of which is at present limited to Washington county, New York, the general character of the slate in Vermont and New York is the same. It happens, however, that red slate is produced only in Washington county, New York, it being the only locality in the country producing this variety of slate.

## LABOR AND WAGES.

The slate quarrymen of the country, and to a considerable extent the firms operating the quarries, are either Welsh or of Welsh descent, many of them having learned the methods of quarrying slate in the celebrated quarries of Wales.

The quarries are operated on an average of about 220 days in the year. The idle days are the result of rainy weather and holidays. The first day of every month is regarded as a holiday by the Welsh quarrymen, and no work is ever done by them on Saturday afternoons.

The average wages for the entire country paid to foremen or overseers is $2.48 per day; for quarrymen and millmen, $1.56; for mechanics, $1.64; for laborers, $1.27, and for boys, $0.76. The highest wages are paid in California, while those paid in the most important regions naturally approximate more closely the figures above given as the averages. The following figures represent the average daily wages paid in Pennsylvania: foremen, $2.25; quarrymen, $1.88; mechanics, $1.54; laborers, $1.40, and boys, $0.73. In the Vermont and New York region foremen receive an average of $2.65; quarrymen and millmen, $1.77; mechanics, $1.97; laborers, $1.51, and boys, $0.89.

### TABLE OF GENERAL DEDUCTIONS, BY STATES.

| STATES. | Total value of product. | Total wages. | Total expenses. | Total capital. | PERCENTAGE OF PROFIT ON— | | Percentage of wages to total expense. | Percentage of wages to total value. |
|---|---|---|---|---|---|---|---|---|
| | | | | | Capital. | Value of product. | | |
| Total | $3,482,513 | $2,218,982 | $2,762,122 | $10,569,593 | 6.82 | 20.69 | 80.34 | 63.72 |
| California | 18,089 | 31,085 | 44,245 | 85,800 | —30.48 | —144.60 | 70.26 | 171.84 |
| Georgia | 15,330 | 11,371 | 13,551 | 155,000 | 1.15 | 11.60 | 83.91 | 74.17 |
| Maine | 219,500 | 125,640 | 151,090 | 1,141,000 | 6.00 | 31.17 | 83.16 | 57.24 |
| Maryland | 110,008 | 65,255 | 85,444 | 334,000 | 7.35 | 22.33 | 76.37 | 59.32 |
| New Jersey | 10,925 | 7,367 | 9,127 | 103,550 | 1.74 | 16.46 | 80.72 | 67.43 |
| New York | 126,603 | 81,797 | 98,289 | 287,680 | 9.84 | 22.36 | 83.22 | 64.61 |
| Pennsylvania | 2,011,726 | 1,283,535 | 1,631,022 | 6,863,002 | 5.55 | 18.92 | 78.70 | 63.80 |
| Vermont | 842,013 | 517,257 | 616,113 | 1,299,451 | 17.38 | 26.83 | 83.95 | 61.43 |
| Virginia | 113,079 | 80,920 | 95,246 | 181,500 | 9.83 | 15.77 | 84.96 | 71.56 |
| Other states (*a*) | 15,240 | 14,755 | 17,995 | 118,610 | —2.32 | —18.08 | 81.99 | 96.82 |

*a* There are here grouped, in order that the business of individual establishments may not be disclosed to the public, Arkansas, Michigan, and Utah.

TABLE OF GENERAL DEDUCTIONS, BY REGIONS.

| REGIONS. | Total value of product. | Total wages. | Total expenses. | Total capital. | PERCENTAGE OF PROFIT ON— | | Percentage of wages to total expenses. | Percentage of wages to total value. |
|---|---|---|---|---|---|---|---|---|
| | | | | | Capital. | Value of product. | | |
| Total | $3, 482, 513 | $2, 218, 982 | $2, 762, 122 | $10, 569, 593 | 6. 82 | 20. 69 | 80. 34 | 63. 72 |
| California | 18, 089 | 31, 085 | 44, 245 | 85, 800 | −30. 48 | −144. 60 | 70. 26 | 171. 84 |
| Maine | 219, 500 | 125, 640 | 151, 090 | 1, 141, 000 | 6. 00 | 31. 17 | 83. 16 | 57. 24 |
| Peach Bottom region, comprising Harford county, Maryland, and York county, Pennsylvania. | 146, 565 | 81, 066 | 105, 037 | 458, 000 | 9. 07 | 28. 33 | 77. 18 | 55. 31 |
| New Jersey | 10, 925 | 7, 367 | 9, 127 | 103, 550 | 1. 74 | 16. 46 | 80. 72 | 67. 43 |
| Bangor region, Pennsylvania | 707, 162 | 446, 272 | 555, 239 | 1, 888, 575 | 8. 04 | 21. 48 | 80. 37 | 63. 11 |
| Lehigh region, Pennsylvania | 690, 382 | 390, 578 | 508, 219 | 2, 352, 993 | 7. 74 | 26. 39 | 76. 85 | 56. 57 |
| Northampton Hard Vein region, Pennsylvania | 184, 595 | 143, 969 | 177. 695 | 972, 609 | 0. 71 | 3. 74 | 81. 02 | 77. 99 |
| Pen Argyl region, Pennsylvania | 393, 030 | 286, 905 | 370, 276 | 1. 524, 825 | 1. 49 | 5 79 | 77. 48 | 73. 00 |
| Vermont and New York region, comprising Rutland county, Vermont, and Washington county, New York. | 968, 616 | 599, 054 | 714, 402 | 1, 587, 131 | 16. 02 | 26. 25 | 83. 85 | 61. 85 |
| Virginia | 113, 079 | 80, 920 | 95, 246 | 181, 500 | 9. 83 | 15. 77 | 84. 96 | 71. 56 |
| Georgia | 15, 330 | 11, 371 | 13, 551 | 155, 000 | 1. 15 | 11. 60 | 83. 91 | 74. 17 |
| Other states (*a*) | 15, 240 | 14, 755 | 17, 995 | 118, 610 | −2. 32 | −18. 08 | 81. 99 | 96. 82 |

*a* There are here grouped, in order that the business of individual establishments may not be disclosed to the public. Arkansas, Michigan, and Utah.

# GRINDSTONES.

The value of grindstones produced in the United States in 1889 was $439,587 (*a*), distributed as follows: Ohio, $430,398; South Dakota, $7,131, and California, $2,058.

It will be seen from the above that production was almost wholly confined to Ohio. The formation which furnishes material suitable for grindstones is that most generally known as the Berea grit. It is a member of the subcarboniferous measures of Ohio, and outcrops in different places in the northern and eastern portions of the state and near the shores of Lake Huron in Michigan. The stone varies in different places, being valuable for building purposes in some localities and suitable for grindstones in others. The principal centers for the quarrying of this rock for grindstones are Berea, Amherst, Independence, Massillon, Lorain, Grafton, and Marietta. The manufacture of finished stones from the rough blocks is carried on principally at Cleveland.

The California production comes from Santa Clara county, and that of South Dakota from Lawrence county.

The United States imports grindstones from Nova Scotia and England, and exports to Mexico, the West Indies, and the states of South America.

The statistics of labor, wages, capital, power, etc., of the grindstone industry are included under sandstone.

The following tables show the value of the grindstones produced in the United States from 1880 to 1889, inclusive, and the imports from 1868 to 1889, inclusive:

VALUE OF GRINDSTONES PRODUCED IN THE UNITED STATES, 1880 TO 1889, INCLUSIVE.

| YEARS. | Value. | YEARS. | Value. |
|---|---|---|---|
| 1880 | $500, 000 | 1885 | $500, 000 |
| 1881 | 500, 000 | 1886 | 250, 000 |
| 1882 | 700, 000 | 1887 | 224, 400 |
| 1883 | 600, 000 | 1888 | 281, 800 |
| 1884 | 570, 000 | 1889 | 439, 587 |

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*a* This figure is included in that representing the value of sandstone in the chapter on that subject.

### GRINDSTONES IMPORTED AND ENTERED FOR CONSUMPTION IN THE UNITED STATES, 1868 TO 1889, INCLUSIVE.

[Long tons.]

| YEARS ENDING— | Total value. | FINISHED. | | UNFINISHED OR ROUGH. | |
|---|---|---|---|---|---|
| | | Quantity. | Value. | Quantity. | Value. |
| June 30, 1868 | $60, 855 | ... | $25, 640 | ... | $35, 215 |
| 1869 | 115, 593 | ... | 15, 878 | ... | 99, 715 |
| 1870 | 125, 605 | ... | 29, 161 | ... | 96, 444 |
| 1871 | 104, 716 | 385 | 43, 781 | 3, 957. 15 | 60, 935 |
| 1872 | 113, 947 | 1, 202 | 13, 453 | 10, 774. 80 | 100, 494 |
| 1873 | 111, 933 | 1, 437 | 17, 033 | 8, 376. 84 | 94, 900 |
| 1874 | 106, 010 | 1, 443 | 18, 485 | 7, 721. 44 | 87, 525 |
| 1875 | 107, 814 | 1, 373 | 17, 642 | 7, 656. 17 | 90, 172 |
| 1876 | 90, 189 | 1, 681 | 20, 262 | 6, 079. 34 | 69, 927 |
| 1877 | 77, 121 | 1, 245 | 18, 546 | 4, 979. 75 | 58, 575 |
| 1878 | 68, 129 | 1, 463 | 21, 688 | 3, 669. 41 | 46, 441 |
| 1879 | 77, 247 | 1, 603 | 24, 904 | 4, 584. 16 | 52, 343 |
| 1880 | 76, 274 | 1, 573 | 24, 375 | 4, 578. 59 | 51, 899 |
| 1881 | 87, 128 | 2, 064 | 30, 288 | 5, 044. 71 | 56, 840 |
| 1882 | 97, 225 | 1, 705 | 30, 286 | 5, 945. 61 | 66, 939 |
| 1883 | 105, 852 | 1, 755 | 28, 055 | 6, 945. 63 | 77, 797 |
| 1884 | 86, 286 | ... | ... | ... | ... |
| 1885 | 50, 579 | ... | ... | ... | ... |
| Dec. 31, 1886 | [a]39, 149 | ... | ... | ... | ... |
| 1887 | [a]50, 312 | ... | ... | ... | ... |
| 1888 | [a]51, 755 | ... | ... | ... | ... |
| 1889 | [a]57, 751 | ... | ... | ... | ... |

[a] Classed as unfinished.

# PRECIOUS STONES.

# PRECIOUS STONES.

BY GEORGE FREDERICK KUNZ.

The statistics of this report are divided into two sections: first, the discoveries and finds of precious and semiprecious stones in the United States, and the mineral specimens sold for museums and private collections or for bric-a-brac purposes; second, the diamond-cutting industry.

## DISCOVERIES OF PRECIOUS STONES.

Up to the present time there has been very little mining for precious or semiprecious stones in the United States, and then only at irregular periods. It has been carried on during the past few years at Paris, Maine; near Los Cerrillos, New Mexico; in Alexander county, North Carolina, from 1881 until 1888, and on the Missouri river, near Helena, Montana, since the beginning of 1890. True beryls and garnets have been frequently found as a by-product in the mining of mica, especially in Virginia and North Carolina. Some gems, such as the chlorastrolites, thomsonites, and agates of Lake Superior, are gathered on beaches, where they have fallen from rock which has gradually disintegrated by weathering and wave action. It is the intention here to show only the recent discoveries, and especially those in 1889. A more extended account of the occurrence of precious stones is found in "Gems and precious stones of North America", by the same author.

### DIAMOND.

A very limited number of diamonds have been found in the United States. They are met with in well-defined districts of California, North Carolina, Georgia, and recently in Wisconsin, but up to the present time the discoveries have been rare and purely accidental. Their occurrence is chiefly confined to a belt of country lying along the east flank of the southern Alleghenies from Virginia to Georgia, of Archæan and Cambrian age, and another along the western bases of the Sierra Nevada and the Cascade ranges, in northern California and southern Oregon. In both districts the diamonds are found in loose material, the débris of the crystalline rocks of the adjacent mountains, among deposits of gravel and earth, associated with garnet, zircon, iron sand, monazite, anatase, and particularly gold. Hitherto they have never been obtained in quantities to justify an attempt at diamond mining, although some specimens have been of local interest and of market value.

The rocks in the diamond-bearing localities in the southern states are mainly granitic, and the mode of occurrence approaches that of the diamond fields of Brazil and parts of India, but differs entirely from that of South Africa. The similarity of the associated minerals is due to the fact that these loose deposits in both regions are merely the débris of the crystalline rocks of the adjacent mountains.

In both these regions, as well as on Plum creek, Pierce county, Wisconsin, the diamonds have been found in the search for gold; in the south and in California, in placer mining, in the flumes and sluices of the hydraulic workings, and in California frequently in the batteries of the stamps. They have often been overlooked, unrecognized, or destroyed by rude methods of testing. The entire finds may be summed up as follows: the octahedral diamond, weighing 24.75 carats, at Manchester, opposite Richmond, Virginia, in 1854, which was cut into a gem weighing 11.34 carats; about 100 diamonds, weighing from 0.25 carat to 5 carats, in the North Carolina and Georgia localities; about 200 diamonds, from 0.5 carat to 4 carats each, in California; 2 diamonds in Indiana; 7 small ones, none weighing as much as 1 carat, at Plum creek, Pierce county, Wisconsin; and a few isolated diamonds reported from Idaho, Arizona, Arkansas, and Adair county, Kentucky.

### SAPPHIRE.

The corundum gems, sapphire, ruby, oriental emerald, etc., have been found in only 2 states, North Carolina and Montana, and then never in fine gems.

At Corundum Hill, Macon county, North Carolina, about 100 gems have been found during the last 20 years, some of good blue color and some of good red color, but none exceeding $100 in value, and none within the past 10 years. One crystal of oriental emerald (green corundum) that has not been cut would furnish at least $1,000 worth of cut gems. Brown asteroid corundum star or asteria sapphire is also found at this locality.

In Montana sapphires have been found on the bars for 6 miles along the Missouri river, at what are known as Eldorado, Spokane, French, and Ruby bars. Spokane bar is about the central point, and is about 12 miles west of Helena. The deposits may extend farther up and down the river. No systematic attempt has been made to work these bars for sapphire, although they were pretty thoroughly sluiced for gold as early as 1865. Since then the sapphires have been sent east occasionally, but not until recently have they received much recognition, owing to the high price of cutting sapphire gems and the small demand then existing for stones other than those of a positive color, such as true ruby red or sapphire blue. About 1880 some $2,000 worth were sold annually.

In 1889 an area of about 4,000 acres was secured by a company that contemplated working Eldorado bar, Ruby bar, and others on the Missouri river. The property has been prospected by mining engineers, who estimate that Eldorado bar will yield some 2,000 ounces of sapphires to the acre, but only a part of these may be of such quality as to warrant cutting. The stones found embrace a great variety of the lighter shades of red, yellow, blue, and green. The latter color is found quite pronounced, being rather a blue green than an emerald green, sometimes slightly asteriated, and generally dichroitic; that is, blue in one direction and red in the other. Nearly all the stones when finely cut have an apparent metallic luster, which is strikingly peculiar to those from this locality. No true red rubies nor any true blue sapphires have been found. Frequently the blues and greens assume a red tint by artificial light. The sapphires are principally found in a layer of auriferous glacial gravel a few inches in thickness, which lies immediately on a slaty bed rock.

Among the associated minerals observed were white topaz in brilliant crystals, garnets in rounded grains, occasionally as large as a pea and rich ruby red in color (often mistaken for and called rubies), cyanite, chalcedony, cassiterite, and limonite in rolled pebbles.

Fancy stones of from 4 to 6 carats each are frequently met with, and a fine one of 9 carats was found, of a rich greenish-blue color. The value of gems cut from the material found in this district amounted at one time to over $2,000 a year. In 1889 a dike of eruptive rock was discovered cutting the slaty rock at Ruby bar, on which rests the glacial gold gravel. In this eruptive rock there were found crystals of sapphire, pyrope garnet, and sanidine feldspar; so that there can be little doubt that all the sapphires that have been found along the Missouri river have come from the breaking down of a rock similar to this, and it is very evident that some outcroppings have been eroded by glacial action north of all the bars. The precise locality, however, is a question. They can not have come from the eruptive rock deposit at Ruby bar, because this locality is 6 miles south of Eldorado bar, where a number of sapphires have been found, but rather from some dikes, now worn away or covered over, north of Eldorado bar.

### CHRYSOBERYL.

Chrysoberyl has been obtained in large crystals, some weighing several pounds, but opaque and of no gem value, at Stoneham, Norway, and other localities in Maine; also at Haddam, Connecticut, and Greenfield, near Saratoga, New York. The alexandrite variety has not been observed.

### SPINEL.

A few smoky-blue and dark velvety-green gems were formerly obtained near Hamburg, Sussex county, New Jersey, and occasionally in the limestone with sapphire and ruby, not transparent, from Amity, New York, to Andover, New Jersey, a distance of 30 miles. This occurrence in limestone is almost identical with the occurrence of the oriental or true ruby and spinel at the famous mines in the valley of the Mogok, near Mandalay, Burmah. Immense black opaque crystals of spinel, some 4 inches in diameter, were formerly obtained in great quantities from a locality near Monroe, New York.

### BERYL.

Of the beryl gems (emerald, aquamarine, and golden beryl) the emerald has been mined to some extent at Stony Point, in Alexander county, North Carolina, and has also been obtained at 2 other places in the county. Nearly everything found has come from the Emerald and Hiddenite mines, where, during the past decade, emeralds have been mined and cut into gems to the value of $1,000, and also sold as mineralogical specimens to the value of $3,000; lithia emerald, or hiddenite (which is mineralogically a variety of spodumene), to be cut into gems, $8,500, and for mineralogical specimens, $1,500; rutile, cut and sold as gems, $150, and as specimens, $50; and beryl, cut and sold as gems, $50.

At an altitude of 14,000 feet, on Mount Antero, Colorado, during the last 3 years material has been found which has afforded $1,000 worth of cut beryls. At Stoneham, Maine, fine aquamarine has been found, which was cut into about $1,500 worth of gems.

At New Milford, Connecticut, a property was extensively worked from October, 1885, to May, 1886, for mica and beryl. The beryls were yellow, green, blue, and white in color, the former being sold under the name of "golden beryl". No work has been done at the mine since then. In 1886 and 1887 there were about 4,000 stones cut and sold for some $15,000, the cutting of which cost about $3,000.

### TOPAZ.

Small brilliant crystals have been found at Thomas mountain, Sevier county, Utah; in northern Colorado, in wine-colored crystals, at Devils Head mountain, 30 miles from Pikes Peak, and on Cheyenne mountain, near Pikes Peak, in splendid crystals, colored light blue, light green, and white. A single crystal weighed over 1 pound. Several thousand dollars' worth were sold as specimens, and fully 3,000 have been cut. 2 exceptional gems weighed 125 and 193 carats, respectively. At Stoneham, Maine, large crystals with little transparency have been found. At Bald mountain, North Chatham, New Hampshire, topaz occurs with phenacite in fine crystals. Fully $1,000 worth have been found in 1 year.

### PHENACITE.

In fine transparent crystals, phenacite has been found associated with topaz at 3 localities near Pikes Peak, Colorado, also at Mount Antero, Colorado, and Bald mountain, New Hampshire. Many of the crystals found would do to cut into gems, but its value is almost purely due to its mineralogical interest.

### TOURMALINE.

Tourmaline has been found for the past 60 years at Mount Mica, Paris, Maine, in magnificent crystals, which have often furnished gems rivaling any ever found. Fully $50,000 worth of gems and crystals have been found here. Fine crystals have been found at Auburn and Hebron, Maine.

### SPODUMENE, OR LITHIA EMERALD (HIDDENITE).

Spodumene, or lithia emerald (hiddenite), is a transparent variety of spodumene, varying from yellow green to a deep, brilliant, almost emerald green, with yellowish reflections. It is found in Alexander county, North Carolina (see Beryl). About $8,500 worth of material has been cut into gems or sold as specimens during the past 10 years.

### GARNET.

The finest known garnets and nearly all the peridots found in the United States are obtained in the Navajo nation, in the northwestern part of New Mexico and the northeastern part of Arizona, where they are collected from ant-hills and scorpion nests by Indians and by the soldiers stationed at the adjacent forts. Generally these gems are traded for stores to the Indians at Gallup, Fort Defiance, Fort Wingate, etc., who in turn send them to large cities in the east in parcels weighing from 0.5 ounce to 30 or 40 pounds each. These garnets, which are locally known as Arizona and New Mexico rubies, are the finest in the world, rivaling those from the Cape of Good Hope. Fine gems weighing from 2 to 3 carats each and upward when cut are not uncommon. The peridots found associated with garnets are generally 4 or 5 times as large, and from their pitted and irregular appearance have been called "Job's tears". They can be cut into gems weighing 3 or 4 carats each, but do not approach those from the Levant either in size or color. These garnets present a large variety of tints, of rich red, claret, almandine, and even yellow essonite-colored stones. They are often believed by the finders to be spinels or rubies and are frequently sold as "Arizona", "Colorado", or "New Mexican" rubies.

Although the garnets found in the South African diamond mines, the so-called "Cape rubies", are of larger size than those of Arizona and New Mexico, which are rarely over 2 or 3 carats, and perhaps equal to them in color by daylight, the latter are much superior by artificial light, only the clear, blood-red hue being visible, while in the "Cape rubies" the dark color still remains unchanged. They are extensively used as gems, the annual sales amounting to $5,000 worth of cut stones. A few remarkably fine ones have brought $50 each, though stones of equal quality have frequently sold for much less. These garnets have never been found in place by any geologist or any surveyor, but it is evident from the associated minerals that they have weathered out of a peridotite rock. They are from one-eighth to one-fourth of an inch in diameter, rarely over one-third, and but few have been seen measuring two-thirds of an inch. In form they are generally round and pitted, like large currants, but often with fractured edges.

Pyrope garnets of good color, that have furnished gems, have been found in the sands of the gold washings of Burke, McDowell, and Alexander counties, North Carolina. In the peridotite and in the débris resulting from its weathering, at Isons Mills, Elliott county, Kentucky, are found deep ruby-red grains of pyrope garnet in considerable quantity.

In Burke county, North Carolina, especially near Warlick, large quantities of purple garnet (almandite) have been found in crystals weighing up to 20 pounds each, and many tons have been ground into emery. They are often fine enough to cut into watch jewels and into small dishes.

At Ruby mountain, 3 miles from Salida, Chaffee county, Colorado, is a remarkable deposit of opaque and translucent almandite garnet crystals, in a bed of soft green chlorite, out of which they fall when the rock is broken. These crystals vary in weight from 1 ounce to 12 pounds. 2 very perfect crystals, weighing, respectively, 14 and

14.5 pounds, were simple dodecahedrons in form, and altered to chlorite superficially, often to the depth of a tenth of an inch. Internally they are very compact and often show 2 or 3 distinct zones of color, but not being transparent they are not of gem value. At least 5 tons of these crystals have been sold to collectors and tourists for specimens, paper weights, ornaments, etc. They are compact enough to make them valuable for watch jewels or for ornamental purposes.

Large quantities of purple almandite garnet, in the form of rolled fractured pieces, have been found along the Columbia river, in the states of Washington and Oregon.

On the Stickeen river, near Fort Wrangell, Alaska, are deposits of mica containing perfect crystals of almandite garnet ranging in size from 0.5 inch to 2 inches in diameter. These are mined by the ton and sold to tourists or sent to the United States for cabinet specimens.

Essonite (cinnamon garnet, cinnamon stone, or the hyacinth of the jeweler) occurs sparingly in good quality in Phippsburg, Oxford county, Maine, and Warren, New Hampshire. Beautiful transparent flattened crystals are found between plates of mica at Avondale quarry, Pennsylvania, and near Bakersville, North Carolina. At Amelia Court House, Virginia, a large quantity of spessartite garnet, a variety of essonite, in which part of the alumina is replaced by manganous oxide, has been found in masses several inches across, and of dark brown, dark red, and honey-yellow colors. These are the finest specimens of this variety of garnet ever found, and have yielded gems of from 1 to 100 carats in weight, almost rivaling the essonite from Ceylon.

### TURQUOISE.

This mineral, which was worked by the Aztecs before the advent of the Spaniards, and since then by the Pueblo Indians, and largely used by them for ornament and as an article of exchange, is now systematically mined near Los Cerrillos, New Mexico. Its color is blue, and its hardness is fully equal to that of the Persian, or slightly greater, owing to impurities. All found previous to this year lacked that softness of color belonging to the Persian turquoise, but the recent find compares favorably.

From time immemorial this material has been rudely mined by the Indians. Their method is to pour cold water on the rocks after previously heating them by fires built against them. This process generally deteriorates the color of the stone to some extent, tending to change it to a green. The Pueblos barter turquoise with the Navajo, Apache, Zuñi, San Felipe, and other New Mexican tribes for their baskets, blankets, silver ornaments, and ponies, to the value of over $3,000 annually.

In 1870 an unsuccessful attempt was made to work an ancient locality at Los Cerrillos, the scene of the disaster which led to the insurrection 3 centuries before. It was believed that the rock which contained the turquoise would yield enough gold to pay for the working and thus the turquoise would be the profit. All the stones found at that time were too green to have much commercial value. During the past year an ancient mine 7 miles from the old workings, has been reopened and a 75-foot shaft has been sunk. The turquoise is good in color, better than any heretofore found; and although none as fine as the best Persian has been obtained, the yield for the entire year is said to have been sold for over $10,000. Turquoise has been observed in Fresno county, California; Humboldt county, Nevada: Saguache county, Colorado; at 3 localities in Arizona, and at a new locality in Grant county, New Mexico.

### QUARTZ.

During the year 1887 about half a ton of rock crystal, in pieces weighing from a few pounds up to 100 pounds each, was found in decomposing granite in Chestnut Hill township, Ashe county, North Carolina. One mass of 20.5 pounds was absolutely pellucid, and more or less of the material was used for art purposes. This lot of crystal was valued at $1,000.

A number of quartz crystals almost entirely pellucid, weighing up to 50 pounds each, have been found near Placerville, California.

In Arkansas, especially in Garland and Montgomery counties, rock crystals occur lining cavities of variable size, and in one instance 30 tons of crystals were found in a single cavity. These crystals are mined by the farmers in their spare time and sold in the streets of Hot Springs, their value amounting to some $10,000 annually. Several thousand dollars' worth are cut from quartz into charms and faceted stones, although 10 times that amount of paste or imitation diamonds are sold as Arkansas crystals.

Rose quartz is found in the granitic veins of Oxford county, Maine, and in 1887, 1888, and 1889 probably $500 worth of this material was procured and worked into small spheres, dishes, charms, and other ornamental objects.

### AMETHYST.

Light-colored crystals are found in great quantity at Stow, Maine. Occasionally a superb gem is also found in magnificent purple crystals in Upper Providence township, Delaware county, Pennsylvania; at many localities in Colorado, and the Yellowstone Park, associated with agate and agatized wood, generally of little value, however.

### GOLD QUARTZ.

Since the discovery of gold in California, compact gold quartz has been extensively used in the manufacture of jewelry, at one time to the amount of $100,000 per annum. At present, however, the demand has so much decreased that only from $5,000 to $10,000 worth is annually used for this purpose.

In addition to the mineral used for cabinet specimens, etc., there is a great demand for making clocks, inkstands, and other objects.

To be of value for jewelry and souvenirs, the quartz must be clear, compact, white, containing veins, streaks, or spots of fine gold. The white gold quartz of California is mainly supplied from the counties of Butte, Calaveras, Eldorado, Mariposa, Nevada, Placer, Sierra, Tuolumne, and Yuba. The mines of California, Oregon, and Montana have furnished very fine specimens. The gold found in California quartz is worth about $16.50 an ounce, but jewelers willingly give from $20 to $30 for each ounce of gold contained in material that they can use. The price of specimens is governed by their beauty, varying from $3 to $40 per ounce of quartz.

### AGATE.

Agate, chalcedony, carnelian, sard, and other varieties of the agate group are abundant at many places in North America. At Agate bay, Lake Superior, large numbers of small banded agates, often of a rich red color are found. Often these natural pebbles are polished all over, then drilled at one end, and sold to tourists as charms, or they are placed in bottles of water to show the markings to the best advantage, neatly arranged according to color and size, and sold as mementoes. Many fine agates, some of great beauty, are found in Colorado and elsewhere through the Rocky mountains, but only a few are polished, because the agates from Brazil and Uruguay can be cut in Germany and sold at much lower rates, so that nearly all the polished agates sold in America are from the German market.

Moss agate is found in great quantity in Wyoming, Colorado, Utah, and Montana. It was formerly used in jewelry by the ton, as much as $20,000 worth being sold annually. When this stone was fashionable, as much as $5 to $10 was paid for a single stone; those found in brooks, so-called "river agates", were preferred. At present not over $1,000 worth is sold, and this only in tourists' jewelry.

The well-known agatized and jasperized wood of Arizona is so much richer in color than that obtained from any other known locality that, since the problem of cutting and polishing the large sections used for table tops and other ornamental purposes was solved, fully $50,000 worth of the rough material has been gathered, and over $100,000 worth of it has been cut and polished. Single tree-sections 40 inches in diameter, columns drilled out of the solid trunks 10 to 12 inches in diameter, and other difficult pieces have been cut and polished. This wood, which was a very prominent feature at the Paris Exposition, promises to become one of our richest ornamental materials. It is one of the most important of the ornamental stones—in fact, the richest ornamental stone of modern times.

Chalcedony park, which is the nearest of the 3 so-called forests in this formation on the Atlantic and the Pacific railroad, is about a mile square, and is inclosed by table-lands from 50 to 100 feet in height. Nearly all the agatized wood is on the flat plain below these table-lands and rests on layers of sandstone. The lower layer is chocolate-red, another white, another black, and another (a compact sandstone) gray; and on these rests a layer of white sandstone, in which originally was found all the wood at this locality. It is by the washing and weathering away of this formation that the tree trunks have rolled down to the level plain below. None of those lying below were ever in place there. None in the upper layer are in the upright position, nor were any of the roots visible; and, since none of the trees retain any of the original bark, it seems very probable that all this deposit was once the bed of an inland sea or lake.

### OPAL.

Only at 2 localities in the United States has opal of gem value been observed. A single pebble of fire opal was found on the John Davies river, Oregon.

During the past year, near Whelan, southwest of Colfax, Washington, between the Cœur d'Alene and Nez Percés Indian reservations, almost on the Idaho and Washington lines, a brilliant fire opal and noble opal were found in the form of grains about the size of a pea, filling the cavities in an amygdaloid basalt rock. The quality of this opal is good and this may be a promising locality. Some of it is very fine, the value depending on the quantity found. It occurred more or less plentifully, as the last 4 feet of the rock contained cavities filled with precious opal. This opal occurs in a basalt in which most, if not all, of the feldspar and pyroxene, as well as the green mass, appear to be altered.

### AMAZON STONE.

At the Crystal beds and other localities near Pike's Peak, Colorado, amazon stone (microcline) is found in large cavities in a coarse pegmatite granite with flesh-colored and white feldspars, as well as smoky quartz crystals, all often of huge size. Many thousand crystals of the most beautiful green color have been obtained here, some measuring from one-half an inch to over a foot in length, and of different shades of green, from the lightest and most delicate to a deep apple green. From the Pike's Peak locality 1 dealer sold over $8,000 worth as minerals. As high as

$200 was paid for a single specimen. Over $1,000 worth from this place are annually cut into tourists' jewelry. Tons of rich green cleavages were found at the Allen mica mines, Amelia Court House, Virginia, with beautiful albite moonstone resembling that from Ceylon in quality, transparency, and color, and forming gems 0.5 inch across, and opaque cleavages 4 inches square, showing a delicate blue chatoyancy.

Labrador spar is found in large quantities in Lewis and Essex counties, New York, occurring as bowlders in the drift all the way down to Long Island and New Jersey. A common variety, used for building purposes, is quarried at Keeseville, Lewis county, where the bowlders are so plentiful in the river that it has been named Opalescent river.

### CHLORASTROLITE, THOMSONITE, ETC.

Chlorastrolite in pebbles is found principally on the inner and outer shores of Rock harbor, a harbor about 8 miles in length on the east end of Isle Royale, Lake Superior, where they occur from the size of a pin head to (rarely) the size of a pigeon's egg. When larger than a pea they frequently are very poor in form, or are hollow, in fact, and unfit for cutting into gems. They are collected in a desultory manner, and are sold by jewelers of Duluth, Petoskey, and other cities, principally to visitors. The annual sale ranges from $200 to $1,000.

Thomsonite and lintonite in pebbles occur with the chlorastrolites at Isle Royale, but finer stones are found on the beach at Grand Marais, Cook county, Minnesota. Like the chlorastrolites, they result from the weathering of the amygdaloid rock, in which they occur as small nodules, and in the same manner are sold by jewelers in the cities bordering on Lake Superior to the extent of $200 to $1,000 worth annually.

### MALACHITE.

Malachite, although found in many localities in the United States, and sometimes abundant with ores of copper, has been found of beauty enough for use in the arts; and at the Copper Queen mine at Bisbee, Arizona, masses weighing 15 pounds and upward have been found, rivaling the Russian in quality, and which by piecing would furnish table tops.

At Morenci, Arizona, there has been found an interesting form of azurite and malachite in rounded stalagmites which, when cut across, have often from 2 to 6 layers of blue and green, forming a very pleasing combination, in concentric zones, both minerals admitting of a beautiful polish.

### CORAL.

Fossil corals, consisting of carbonate of lime, often possess great structural beauty, are very compact, and susceptible of a high polish. These are very plentiful along the shores of Little Traverse bay, at Petoskey, Michigan, where water-worn pieces of various species of coral ranging from fragments the size of a small pebble to masses of 2 or 3 pounds are frequently found. The spaces or cells of these corals are entirely filled with carbonate of lime and, being very compact, they take a fine polish. In color they are of various shades of gray, and many of them exceedingly handsome. The lapidaries of the place cut and polish these corals, and at present probably $4,000 or $5,000 worth are annually sold by them, either polished on one side are in the form of seals, charms, cuff-buttons, paperweights, and other ornaments.

### LODESTONE.

Lodestone, or native magnet, is the magnetic iron oxide. Although not now used as a gem, it was worn centuries ago for the power it was supposed to possess and for the charm it was presumed to give the wearer. Large quantities of it are found at Magnet cove, Arkansas, and it is estimated that several tons are sold annually to the southern negroes to be used by the voudoos, who employ it as a conjuring stone.

### FLUORITE.

Fluorite, in the colored transparent varieties, is designated as false ruby, emerald, sapphire, topaz, amethyst, etc. 30 years ago many superb specimens of the green variety were taken from a vein of this mineral that ran out under Muscalonge lake, Saint Lawrence county, New York. In 1888 several tons of fine green crystals, some a foot square, were found at Macomb, in the same county. Large quantities of superb red, blue, and purple fluorite are found in Hardin county, Illinois, where thousands of tons are mined for industrial purposes.

### PYRITE.

Pyrite, or sulphide of iron, is found in many localities in the United States. Crusts of small crystals are trimmed and cut into ovals, squares, and other shapes, and sold for mounting as scarf pins, lace pins, earrings, ring stones, etc. Fine single crystals are also sold for ornaments in Pennsylvania and Colorado. Several thousand dollars' worth are sold annually.

### AMBER.

Amber has been sparingly observed at a number of localities in central and southern New Jersey, on the Magothy river, Maryland, and in North Carolina and Wyoming, but, up to the present, nowhere in the United States in sufficient quantity to warrant searching for it.

## PRODUCTION OF PRECIOUS STONES, ORNAMENTAL MINERALS, ETC., IN 1889.

| NAMES OF GEMS OR PRECIOUS STONES | Total value. | Value of stones before cutting. | Value of stones after cutting into gems for ornamental purposes. | Value of stones sold as specimens and curiosities, occasionally polished to beautify or show the structure. |
|---|---|---|---|---|
| Total | $188, 807 | | $107, 645 | $81, 162 |
| Sapphire | 6, 725 | , 600 | 6, 725 | |
| Emerald | 450 | | 300 | 150 |
| Aquamarine | 747 | 225 | 597 | 150 |
| Phenacite | 200 | | | 200 |
| Topaz | 400 | 100 | 200 | 200 |
| Turquoise | 23, 675 | 10, 000 | 23, 175 | 500 |
| Tourmaline | 2, 250 | 1, 030 | 2, 250 | |
| Garnet | 2, 308 | 510 | 1, 633 | 675 |
| Quartz | 14, 000 | 510 | 2, 750 | 11, 250 |
| Amethyst | 98 | 15 | 98 | |
| Rose quartz | 600 | 200 | 400 | 200 |
| Smoky quartz | 4, 232 | 700 | 4, 007 | 225 |
| Gold quartz | 9, 000 | 6, 000 | 9, 000 | |
| Rutilated quartz | 30 | 2 | 30 | |
| Dumortierite in quartz | 250 | | | 250 |
| Quartz coated with chalcedony | 4, 000 | 1, 000 | 2, 000 | 2, 000 |
| Chrysoprase | $200 | $50 | $200 | |
| Agatized and jasperized wood | 53, 175 | 42, 725 | 53, 000 | $175 |
| Banded and moss jasper | 630 | | 80 | 550 |
| Amazon stone | 500 | | | 500 |
| Pyrite | 2, 000 | 100 | 500 | 1, 500 |
| Chlorastrolite | 500 | 200 | 300 | 200 |
| Thomsonite | 400 | 100 | 200 | 200 |
| Fluorite | 500 | | | 500 |
| Fossil coral | 700 | 100 | 200 | 500 |
| Azurite and malachite | 2, 037 | 1, 000 | | 2, 037 |
| Catlinite (pipestone) | 5, 000 | | | 5, 000 |
| Zircon (*a*) | 16, 000 | | | 16, 000 |
| Gadolinite, fergusonite, etc. (*a*) | 1, 500 | | | 1, 500 |
| Monazite (*a*) | 1, 000 | | | 1, 000 |
| Spodumene (*a*) | 200 | | | 200 |
| Wooden ornaments decorated with minerals (*b*). | 15, 500 | | | 15, 500 |
| Miscellaneous minerals (*c*) | 20, 000 | | | 20, 000 |

*a* Used to extract the rarer elements for chemical purposes.

*b* Such as clocks, horseshoes, boxes, etc.

*c* For cabinets, museums, etc.

## PRECIOUS STONES AND ORNAMENTAL STONES AND MINERALS FOR CABINETS FOUND IN THE UNITED STATES IN 1889, BY STATES AND TERRITORIES.

| STATES AND NAMES OF MINERALS. | Total value. | Value of stones before cutting. | Value after cutting into gems. | Value of specimens, curiosities, etc., occasionally polished to beautify and show structure. |
|---|---|---|---|---|
| Total | $188, 807 | | $107, 645 | $81, 162 |
| Arizona: | | | | |
| Garnet | 100 | | 100 | |
| Agatized and jasperized wood | 53, 175 | $42, 725 | 53, 000 | 175 |
| Azurite and malachite | 2, 037 | 1, 000 | | 2, 037 |
| Dumortierite in quartz | 250 | | | 250 |
| Wulfenite, vanadinite, etc | 1, 450 | | | 1, 450 |
| Arkansas: | | | | |
| Quartz | 12, 700 | 500 | 2, 700 | 10, 000 |
| Wavellite | 750 | | | 750 |
| California: | | | | |
| Gold quartz | 9, 000 | 6, 000 | 9, 000 | |
| Rose quartz | 200 | | | 200 |
| Chrysoprase | 200 | 50 | 200 | |
| Garnet | 50 | | | 50 |
| Miscellaneous minerals for ornaments. | 5, 000 | | | 5, 000 |
| Colorado: | | | | |
| Smoky quartz | 4, 200 | 700 | 4, 000 | 200 |
| Wood agate and wood jasper | 4, 000 | 1, 000 | 2, 000 | 2, 000 |
| Phenacite | 200 | | | 200 |
| Aquamarine | 400 | 100 | 250 | 150 |
| Garnet | 625 | | | 625 |
| Topaz | 400 | 100 | 200 | 200 |
| Miscellaneous minerals | 6, 100 | | | 6, 100 |
| Mineral clocks, ornaments, etc. | 15, 500 | | | 15, 500 |
| Amazon stone | 500 | | | 500 |
| Pyrite | 2, 000 | 100 | 500 | 1, 500 |
| Kansas: | | | | |
| Banded jasper | 80 | | 80 | |
| Moss jasper | 550 | | | 550 |
| Maine: | | | | |
| Tourmaline | 2, 250 | 1, 030 | 2, 250 | |
| Maine—Continued: | | | | |
| Spodumene | $200 | | | $200 |
| Rose quartz specimens | 400 | $200 | $400 | |
| Miscellaneous minerals | 1, 700 | | | 1, 700 |
| Michigan: | | | | |
| Fossil coral | 700 | 100 | 200 | 500 |
| Minnesota: | | | | |
| Catlinite ornaments | 5, 000 | | | 5, 000 |
| Chlorastrolite | 500 | 200 | 300 | 200 |
| Thomsonite | 400 | 100 | 200 | 200 |
| Montana: | | | | |
| Sapphire | 6, 725 | 2, 600 | 6, 725 | |
| New Mexico: | | | | |
| Garnet | 1, 500 | 500 | 1, 500 | |
| Turquoise | 23, 675 | 10, 000 | 23, 175 | 500 |
| New York: | | | | |
| Quartz | 1, 300 | 10 | 50 | 1, 250 |
| Fluorite | 500 | | | 500 |
| North Carolina: | | | | |
| Aquamarine | 347 | 125 | 347 | |
| Emerald | 450 | | 300 | 150 |
| Amethyst | 98 | 15 | 98 | |
| Garnet | 33 | 10 | 33 | |
| Rutilated quartz | 30 | 2 | 30 | |
| Smoky quartz | 32 | | 7 | 25 |
| Zircon for chemical uses | 16, 000 | | | 16, 000 |
| Monazite | 1, 000 | | | 1, 000 |
| Texas: | | | | |
| Gadolinite and fergusonite | 1, 500 | | | 1, 500 |
| Utah: | | | | |
| Minerals | 2, 500 | | | 2, 500 |
| Virginia: | | | | |
| Quartz, pebbles, etc | 2, 500 | | | 2, 500 |

LABOR EMPLOYED IN PRODUCING PRECIOUS STONES IN 1889.

| STATES. | Number of men employed. | Average daily wages. | Average days employed. | Number of boys employed. | Average daily wages. | Average days employed. | Total expenditures. | Total wages. | Other expenditures. |
|---|---|---|---|---|---|---|---|---|---|
| Total | 187 | $2.50 | 253 | 112 | $1.18 | 265 | $204,117 | $148,355 | $55,762 |
| California | 9 | 3.17 | 258 | ........ | ........ | ........ | 7,995 | 7,225 | 770 |
| Colorado | 10 | 3.58 | 170 | ........ | ........ | ........ | 13,315 | 5,740 | 7,575 |
| Illinois | 49 | 1.51 | 307 | 1 | 0.75 | 185 | 24,804 | 23,880 | 924 |
| Massachusetts | 13 | 2.64 | 301 | 71 | 1.39 | 300 | 64,902 | 39,902 | 25,000 |
| New Jersey | 23 | 2.54 | 152 | 19 | 0.95 | 143 | 12,625 | 10,500 | 2,125 |
| New York | 48 | 3.14 | 257 | 15 | 0.67 | 268 | 41,895 | 40,640 | 1,255 |
| Pennsylvania | 5 | 4.15 | 178 | 3 | 0.62 | 235 | 4,843 | 3,668 | 1,175 |
| Other states (*a*) | 30 | 2.15 | 252 | 3 | 1.00 | 255 | 33,738 | 16,800 | 16,938 |

*a* The states here grouped embrace Missouri, Rhode Island, South Dakota, Virginia, and Wyoming.

## THE DIAMOND-CUTTING INDUSTRY.

In New York there are 16 firms engaged in cutting and recutting diamonds, and in Massachusetts there are 3. Cutting has also been carried on at times in Pennsylvania and Illinois, but has been discontinued. In 1889, 7 of the New York firms ran on full time, but the others were unemployed, respectively, 14, 50, 61, 120, 125, and 240 days, owing to inability to obtain rough material at a price at which it could be advantageously cut. The firms fully employed were generally the larger ones, whose business consisted chiefly in repairing chipped or imperfectly cut stones or in recutting stones previously cut abroad, which, owing to the superior workmanship in command here, could be recut at a profit, or in recutting very valuable diamonds when it was desired, with the certainty that the work could be done under their own supervision, thus guarding against any possible loss by exchange for inferior stones.

It will be seen from the following table that the industry employed 236 persons, of whom 69 were under age, who received $148,114 in wages. Of the 19 establishments, 16 used steam power. The power is usually rented. Foot power is only used in 1 establishment. 3 of the firms are engaged in shaping black diamonds for mechanical purposes, for glasscutters and engravers, or for use in the manufacture of watch jewels.

The average weight of the material before and after cutting is also given in the table. The marked difference in the prices of diamonds, as shown, is due to variations in the weight and quality of the stones.

Beginning in the latter part of 1888, and through 1889, there was a marked increase in the price of rough diamonds, resulting in rapid advances of from 20 to 25 per cent at a time, amounting in all to an advance of from 80 to 100 per cent above the prices of the previous years.

DIAMOND-CUTTING INDUSTRY.

| STATES. | Number of works. | Weight of material before cutting. (Carats.) | Weight after cutting into watch jewels and for mechanical uses. (Carats.) | Value after cutting into gems. | LABOR AND WAGES. Number of men employed. | Average wages per day. | Average number of days employed. | Number of boys employed. | Average wages per day. | Average number of days employed. | Total wages. | Value of machinery used in cutting. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total | 19 | 54,344 | 25,005 | $1,006,716 | 167 | $3.53 | 234 | 69 | $0.65 | 216 | $148,114 | $77,050 |
| Massachusetts | 3 | 4,100 | 1,580 | 41,000 | 11 | 4.10 | 300 | 4 | 1.17 | 300 | 14,934 | 3,000 |
| New York | 16 | 50,244 | 23,425 | 965,716 | 156 | 3.49 | 229 | 65 | 0.62 | 211 | 133,180 | 74,050 |

## IMPORTS.

The diamonds used in this industry are all imported, for, as already stated, diamonds are only occasionally found in the United States. The following table gives the value of imported rough diamonds for a series of years:

VALUE OF IMPORTED ROUGH OR UNCUT DIAMONDS FROM 1873 TO 1889, INCLUSIVE.

| YEARS ENDED— | Value. | YEARS ENDED— | Value. |
|---|---|---|---|
| June 30, 1873 | $176,426 | June 30, 1882 | $449,513 |
| 1874 | 144,629 | 1883 | 443,996 |
| 1875 | 211,920 | 1884 | 367,816 |
| 1876 | 186,404 | 1885 | 371,679 |
| 1877 | 78,033 | 1886 | 302,822 |
| 1878 | 63,270 | 1887 | 262,357 |
| 1879 | 104,158 | 1888 | 322,356 |
| 1880 | 129,207 | 1889 | 250,187 |
| 1881 | 233,596 | | |

The importation of rough and uncut diamonds in 1880 amounted to $129,207, in 1889 to $250,187, and the total for the decade was $3,133,529, while in 1883 there was imported $443,996 worth, showing that there was 94 per cent more cutting done in 1889 than in 1880, but markedly more in 1882 and 1883. This large increase of importation is due to the fact that in the years 1882 to 1885 a number of our jewelers opened diamond-cutting establishments, but the cutting has not been profitably carried on in this country on a scale large enough to justify branch houses in London, the great market for rough diamonds, where advantage can be taken of every fluctuation in the market and large parcels purchased, which can be cut immediately and converted into cash; for nothing is bought and sold on a closer margin than rough diamonds.

As will be seen by the following table, there has been a remarkable increase in the importation of precious stones in this country in the last 10 years. The imports from 1870 to 1879, inclusive, amounted to $26,698,203, whereas from 1880 to 1889, inclusive, the imports amounted to $87,198,114, more than 3 times as much as were imported the previous decade.

IMPORTS OF DIAMONDS AND OTHER STONES, NOT SET, FROM 1867 TO 1889, INCLUSIVE.

| Years ended— | | Years ended— | |
|---|---|---|---|
| June 30, 1867 | $1,317,420 | June 30, 1879 | $3,841,335 |
| 1868 | 1,060,544 | 1880 | 6,690,912 |
| 1869 | 1,997,282 | 1881 | 8,320,315 |
| 1870 | 1,768,324 | 1882 | 8,377,200 |
| 1871 | 2,349,482 | 1883 | 7,598,176 |
| 1872 | 2,939,155 | 1884 | 8,712,315 |
| 1873 | 2,917,216 | 1885 | 5,628,916 |
| 1874 | 2,158,172 | Dec. 31, 1886 | 9,254,438 |
| 1875 | 3,234,319 | 1887 | 10,686,403 |
| 1876 | 2,409,516 | 1888 | 10,223,630 |
| 1877 | 2,110,215 | 1889 | 11,705,809 |
| 1878 | 2,970,469 | | |

# PHOSPHATE ROCK.

# PHOSPHATE ROCK.

BY EDWARD WILLIS.

## SOUTH CAROLINA.

The deposits of phosphate rock in the neighborhood of Charleston and Beaufort, South Carolina, and imported guanos have furnished practically the entire supply of phosphoric acid for all the commercial fertilizers in the United States, bone having been the only other extensive source.

The history of these phosphate deposits has been recorded in various essays. Their existence was known as early as 1797, when they were mentioned by Ramsey. Since then Drayton mentioned them in 1802; Vanuxen in 1824; Shecut and Mills in 1826; Ravenel and Holmes in 1837, and Ruffin in 1844. These authorities spoke of them as extensive beds, but they were known and referred to as marl, that is, calcium carbonate, instead of phosphate. They were mentioned also by J. Lawrence Smith, Hume, Gibbs, Lyell, Toumey, and Agassiz; but they were only known as having a value for calcium carbonate. Mr. Ruffner, of Virginia, who made extended researches and applications of Virginia and South Carolina marls, had many analyses made of each, showing that they were very different in composition. Those of Virginia were easily attacked by weak acids; but the Carolina "marls" were shown to contain silica, compounds of iron, calcium phosphates, and other materials. They were not considered by him applicable to the soil until changed by burning, when he observed that they were far better and more efficient than the Virginia material.

Mr. Toumey first speaks of Charleston marl in 1848, as "marl stones", found in Ashley River basin, at Bees Ferry, at Hanckel, and at Drayton Hall. In 1850, Professor F. S. Holmes read a paper before the American Association for the Advancement of Science, calling the material "marl rock of bowlder-like masses". At that time it was analyzed by Dr. J. Lawrence Smith and Dr. C. U. Shepard, sr. A sample from Dr. Gedding's place, "The Elms", was analyzed by the latter, and declared to contain 18.60 per cent of silica, 68.01 per cent of calcium carbonate, 1.20 per cent of magnesium carbonate, 9.20 per cent of phosphates of calcium, magnesium, peroxide of iron, etc., 0.40 alumina, and 4 per cent of water.

In 1866, Dr. St. Julian Ravenel, Mr. D. C. Ebaugh, and Messrs. W. C. Dickey & Sons imported 400 tons of Navassa rock guano into Charleston. This seems to show clearly the ignorance of the existence of any considerable quantity of phosphate rock in Charleston at that time. In 1867, Dr. St. Julian Ravenel offered to supply Dr. N. A. Pratt with native phosphate rock, and at the same time agreed to take all the sulphuric acid that Dr. Pratt could make. In this same year Dr. Pratt and Professor Holmes took the initiatory steps to bring the South Carolina phosphate to the notice of capitalists, and Mr. James T. Welsman, of the firm of John Frazer & Co., furnished the first capital. Dr. Pratt and Professor Holmes then organized the Charleston Mining and Manufacturing Company, the pioneer company to use South Carolina phosphate rock, and to make it a success Messrs. George F. Lewis, F. Kent, Y. E. Smith, Samuel Fischer, and Samuel Grant, capitalists of Philadelphia, joined them, furnishing the money. The business thus inaugurated grew in importance. Many mining companies were organized and started, among them the Etiwan Company, formed by Dr. Pratt, the first company in the state to use acid chambers. From this time on the phosphate industry continued to enlarge, and, with various fluctuations of depression and prosperity, increased to the extensive operations recorded in later years.

### COMPOSITION.

The crude tests as to the composition given above have, of course, been corrected by many thousands of careful analyses. The appearance and general character of the phosphate rock are quite uniform, with slight differences for land rock or river rock. But the proportion of calcium phosphate in the rock varies widely; analyses of each cargo must be made to establish its value. It is impossible to give a representative analysis, except it be based on an average of many shipments. The following, based on several hundred shipments, may be considered a typical analysis of clean dry rock of good quality:

GENERAL COMPOSITION OF SOUTH CAROLINA PHOSPHATE ROCK.

| | PER CENT. | |
|---|---|---|
| Phosphoric acid (*a*) | 26.0 to | 29.0 |
| Carbonic acid (*b*) | 2.5 | 5.0 |
| Sulphuric acid | 0.5 | 2.0 |
| Lime | 35.0 | 42.0 |
| Magnesia | Traces. | 2.0 |
| Alumina | Traces. | 2.0 |
| Sequioxide of iron | 1.0 | 3.0 |
| Fluorine | 1.0 | 2.0 |
| Sand and silica | 4.0 | 12.0 |
| Organic matter and combined water | 2.0 | 6.0 |
| Moisture | 0.5 | 4.0 |

*a* Equivalent in combination to 57 to 63 per cent of bone phosphate of lime.
*b* Equivalent in combination to 5 to 11 per cent of carbonate of lime.

## LAND AND RIVER ROCK.

There are 2 classes of phosphate deposits, land and river, the extent of the former being estimated January 1, 1890, at 55 square miles and of the latter 50 square miles. Land rock is tolerably uniform in grade. Its color varies from light yellow to heavy brown; it is nearly free from iron and alumina, but contains sufficient carbonate of lime to make an acid phosphate, and from this ammoniated or potash compounds, that promptly dry and remain in a pulverulent state after being treated with sulphuric acid. In the United States land rock has been mainly used, it being preferred to that from the rivers. River rock has, since 1870, been preferred in all foreign markets to the land rock, and much the larger part of that mined still goes abroad. In color it is from gray to blue black, with specific gravity of about 2.4 and hardness about 3.15.

The following map, outlining the deposits of land and river rock, is the work of many authorities. It was prepared for the Centennial Exposition, used again in the report of the Tenth Census, again in bulletin 46 of the United States geological survey, and now it has been brought up to date by the writer.

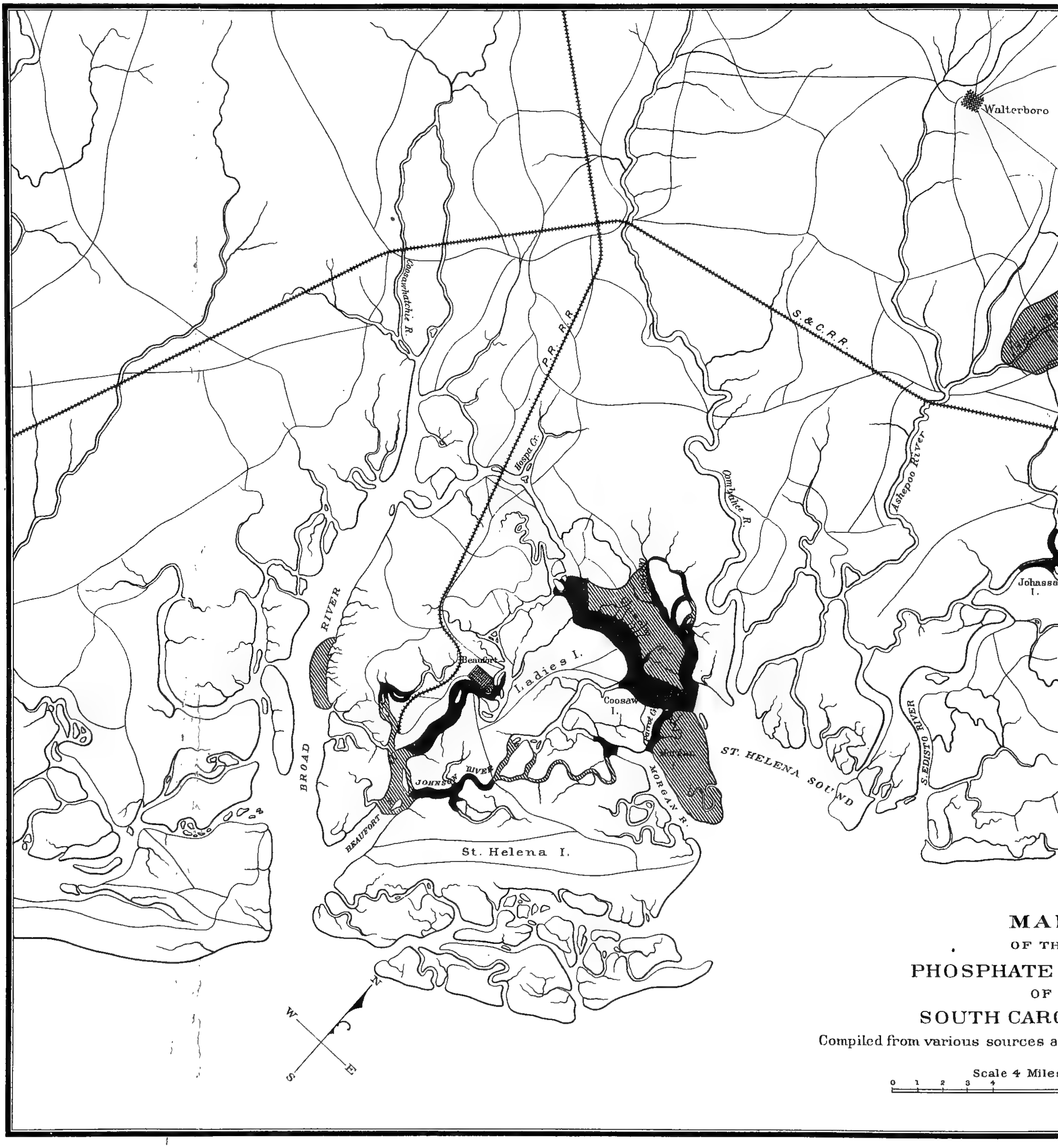
At the lower left-hand corner of the map will be seen the extensive beds at Beaufort and vicinity, and in the Beaufort river and its branches. Then, a little to the right, the Coosaw river and Chisholms island, one of the most prolific sources of phosphate rock in the state. Near the center is shown the section bordering the Edisto river and Horse Shoe creek, where workable deposits are found. There appear farther to the right the deposits of the Stono, Ashley, Cooper, and Wando rivers, and those in the neighborhood of Charleston. The colored sections do not all represent workable deposits, the lighter portions being indicative of the smaller or less profitable sections, and the darker those where mining is extensive or profitable. All the inlets from the sea in the vicinity covered by the map contain more or less phosphate rock. It is found at depths beneath the surface varying from 1 to 20 feet. The nodular stratum varies from a few inches to 2.5 feet in thickness, but the latter is rarely observed. Ordinarily it is from 10 to 15 inches and averages about 10. Where the deposit exceeds 15 inches in thickness this depth rarely extends beyond a limited area, and is generally due to local accumulation, or is the result of accidental superposition of a few large nodules. The yield per acre varies from 500 to 1,200 tons, the average yield of land beds now worked being 800 to 1,000 tons per acre. The yield per acre stands in a certain ratio to the thickness of the stratum, but not invariably so, as the compactness is an important factor in determining the amount of production. In many instances the stratum is underlaid by marl, occasionally to a depth of 250 feet.

## LAND MINING.

The method of land mining of phosphate rock is simple. Long trenches are laid off, from which the overlying earth is first removed. Then by hand labor, with pick and shovel, the rock is taken from the trenches and thrown into piles, from which it is taken by barrows or carts to be washed and crushed. The laborers are usually negroes from the surrounding neighborhood and near towns or cities. Italians were employed several years ago by a number of companies, but they were soon replaced by negroes, who for climatic and other reasons are better adapted to the work.

## RIVER PHOSPHATE.

River phosphate is found in deposits on river beds in depths varying from exposure at low tide to 10 or 15 feet below the surface of the water. It is occasionally found under layers of sand and mud. The nature of the deposit and the depth of the water determine, in large measure, the method of excavation. Where the rock is not over 3


Walterboro
Coosawhatchie R.
P.R.R.
S.&C.R.R.
Hospa Cr.
Combahee R.
Ashepoo River
Johassee I.
BROAD RIVER
Beaufort
Ladies I.
Coosaw I.
ST. HELENA SOUND
MORGAN R.
JOHNSON RIVER
BEAUFORT R.
St. Helena I.
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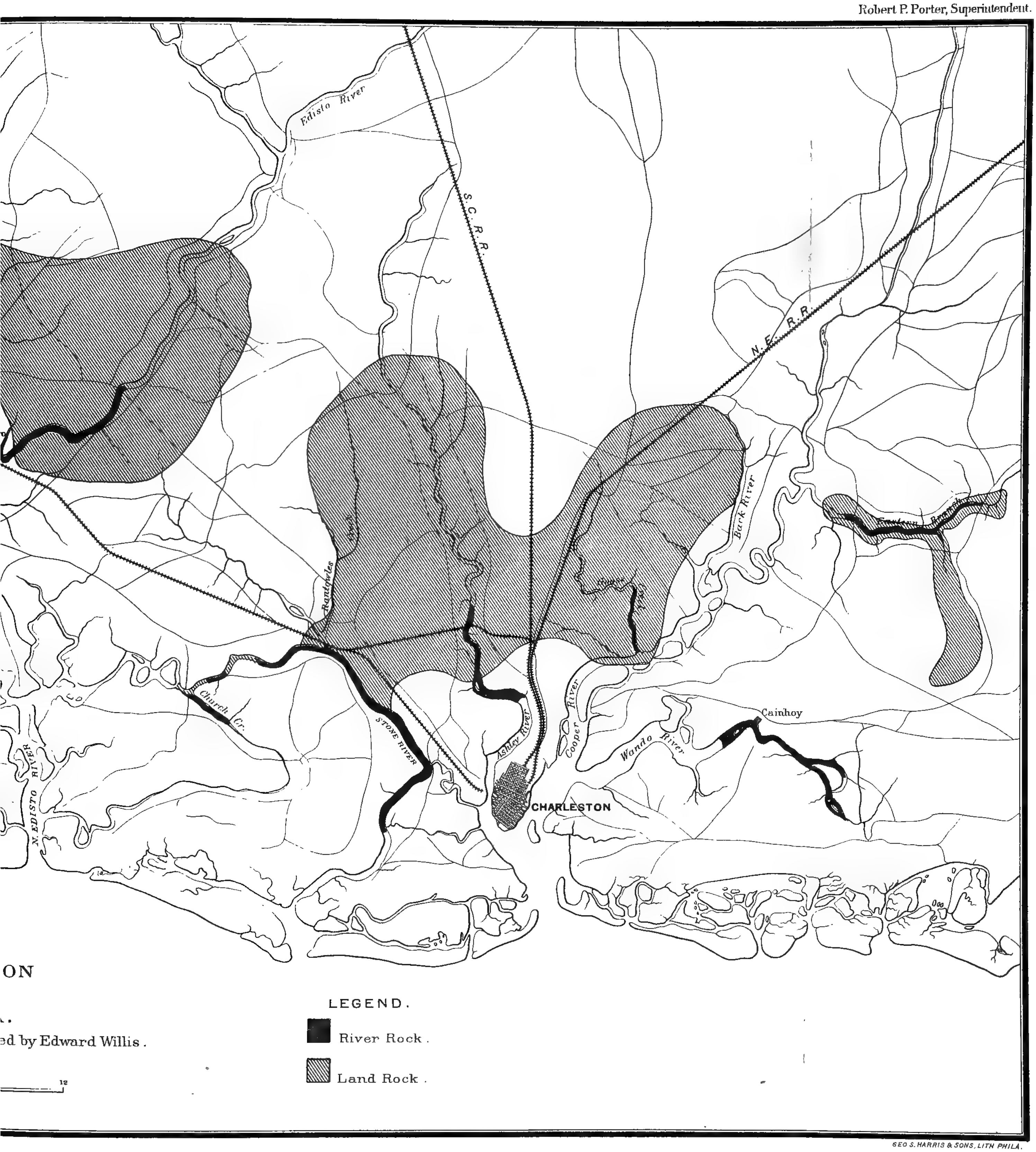
Robert P. Porter, Superintendent.



GEO S. HARRIS & SONS, LITH PHILA.

or 4 feet below the surface of the water, mining is done by hand. In deeper water dredging is resorted to. Where the rock is taken from navigable streams it is the property of the state, and is subject to a royalty of $1 per ton.

### HAND PICKING.

At low water, where the bed is easily accessible, workmen with pick and shovel loosen the rock and throw it on scows or flatboats within convenient reach in shoal water. When the tide rises, the operations cease until the next low tide, and the loaded scows are moved to convenient points for shipment to washers and crushers or for transfer to vessels. The localities in which this mode of mining can be carried on are few, but they have yielded large quantities of rock at moderate cost. In the deeper water, where dredging is not resorted to, much rock is obtained by divers, who with pick and crowbar loosen the material by expertness only attained by those skilled in this particular work. A diver is enabled to bring to the surface rocks which would require the strength of 3 or 4 men to handle above water.

### DREDGING.

The dredging machines are used to most advantage in about 12 feet of water. They are powerful machines, specially made for the work, of several varieties of construction, with claws and scoops capable of raising immense weights. An ordinary day's work, under favorable circumstances, lifts about 100 tons of rock. The rock, having been gathered into dippers or buckets propelled by steam, is emptied on a grating or conical washer, where it is cleansed of the mud and sand by means of heavy streams of water. Marl, sandstone, or oyster shells are then easily detected and thrown aside. The rock, which is partially cleaned, then descends, or is thrown by the machinery on a crusher, and thence into a second washer where the remaining impurities are separated.

The washing apparatus consists of either upright and caldron-shaped or shaft washers, which discharge the washed rock upon lighters for transportation to the drying sheds, where it is heaped upon and around a system of perforated iron pipes. Hot air is then forced through these pipes, and, escaping through the perforations, in a few days thoroughly dries the originally saturated rock.

### MACHINERY FOR LOADING AND DISCHARGING PHOSPHATE ROCK.

The machinery for loading and discharging phosphate rock at the works of the Coosaw Mining Company will serve to explain these processes. At the first and second piers wet phosphate rock is hoisted by donkey engines from lighters, dumped into cars, and in them rolled to the drying bins, where it is piled up on the system of perforated iron pipes to be dried. At the third pier a vessel receives a cargo of dried rock, delivered directly into the hold by dumping cars, which are loaded in drying sheds from large iron buckets hoisted by steam power.

### CRUSHING AND WASHING.

The machinery for crushing and washing the rock is expensive and elaborate. The washer in general use is known as the "single-screw washer". It consists of four half-circular boxes resting in a frame on an incline of 18 inches and 25 feet in length. These boxes are cased with iron. In each box is an octagonal shaft, also cased with iron, and having on each face teeth or blades set at such an angle to the shaft as to form a spiral screw, with a twist of 1 foot in 6 feet. Over each box or washer are strong cylindrical crushers or breakers, armed with steel teeth, acting against an iron plate, and set about 4 inches from the plate. Through these breakers the nodules of rock are dumped and by them broken to a uniform size of 4 inches cube. The rock is then agitated by these bladed shafts, which make about 18 revolutions per minute, and are submerged in water contained in the tub or box. The rock is forced forward and up the incline against a heavy stream of water (which enters at the upper end of the washer box) and empties itself through an overflow at that end. The abrasion of one piece of rock against another in its passage through the box rids it completely of all foreign matter, such as mud, etc. From this overflow it falls upon screens, set one above the other, the first screen having about half-inch mesh and the lower screen about quarter-inch mesh. From this lower screen the fine rock falls upon an oscillating screen still lower, which serves to rinse the small rock thoroughly. Over all these screens a flow of water passes continuously. From them the rock falls upon an elevated platform, and is thence taken to the sheds or storehouses. The water used is drawn directly from the river and forced up into large troughs by means of heavy pumps, both steam and centrifugal. The washers are considerably elevated, for the purpose of getting rid of the débris, which is carried off by means of large troughs. The loss by abrasion and clay adhering to the rock varies from 50 to 60 per cent. The capacity of each washer is from 40 to 50 tons of clean rock in 10 hours.

## PRODUCTION.

The production of phosphate rock in South Carolina for the year 1889 was 541,645 long tons, valued at $2,892,276, against 448,567 long tons in 1888, valued at $2,018,552, and 480,558 tons in 1887, with a value of $1,836,818. It is thus seen that although the production in 1888 was less by 31,991 tons than in 1887, yet the value of the product increased $181,734, or 68 cents per ton. This increase in value was the result of less competition from various sources, due in part to natural conditions of mining and the purchasing ability of the consumers, who depend almost entirely upon the season's crops. The average price per ton in 1889 was $5.34, being an increase of 84 cents per ton over 1888. The increase in 1889 indicates prosperity in the states consuming phosphate rock, which is in keeping with the commercial prosperity to be noted throughout the south.

The total amount expended for wages in the production of phosphate rock, not including office force, during the year 1889, was $1,149,967, against $490,047 reported at the Tenth Census, and the capital invested $5,866,718, against $2,071,300 at the previous census. The total number of persons employed, including office force, was 4,966, against 2,485 reported at the Tenth Census.

The following table gives the annual product of phosphate rock in South Carolina since its mining became an industry, the figures given for the years previous to 1886 being for trade years, ended May 31, but after that date for calendar years:

TOTAL WASHED PRODUCT OF LAND AND RIVER PHOSPHATE ROCK IN SOUTH CAROLINA.

[Long tons.]

| YEARS ENDED— | Total. | Land companies. | River companies. |
|---|---|---|---|
| May 31, 1867 | 6 | 6 | ............ |
| 1868 | 12, 262 | 12, 262 | ............ |
| 1869 | 31, 958 | 31, 958 | ............ |
| 1870 | 65, 241 | 63, 252 | 1, 989 |
| 1871 | 74, 188 | 56, 533 | 17, 655 |
| 1872 | 58, 760 | 36, 258 | 22, 502 |
| 1873 | 79, 203 | 33, 426 | 45, 777 |
| 1874 | 109, 340 | 51, 624 | 57, 716 |
| 1875 | 122, 790 | 54, 821 | 67, 969 |
| 1876 | 132, 478 | 50. 566 | 81, 912 |
| 1877 | 163, 000 | 36, 431 | 126, 569 |
| 1878 | 210, 322 | 112, 622 | 97, 700 |
| 1879 | 199, 365 | 100, 779 | 98, 586 |
| 1880 | 190, 763 | 125, 601 | 65, 162 |
| 1881 | 266, 734 | 142, 193 | 124, 541 |
| 1882 | 332, 077 | 191, 305 | 140, 772 |
| 1883 | 378, 380 | 219, 202 | 159, 178 |
| 1884 | 431, 779 | 250, 297 | 181, 482 |
| 1885 | 395, 403 | 225, 913 | 169, 490 |
| 1885 (*a*) | 277, 789 | 149, 400 | 128, 389 |
| Dec. 31, 1886 | 430, 549 | 253, 484 | 177, 065 |
| 1887 | 480, 558 | 261, 658 | 218, 900 |
| 1888 | 448, 567 | 290, 689 | 157, 878 |
| 1889 | 541, 645 | 329, 543 | 212, 102 |

*a* June 1 to December 31.

The table on the following page, giving the number of establishments engaged in the phosphate rock industry of South Carolina for the census years 1880 and 1889, together with the capital invested, number of hands employed, total amount of wages paid, and total product and its value, shows the steady and healthy growth of the phosphate industry in the state since the taking of the last census. It will be seen that there is an increase of $3,795,418 in invested capital, or 183 per cent; 330,268 tons in production, or 156 per cent, and $1,768,453 in value, or 157 per cent, while the number of employés (not including boys) has increased 2,437, or 101 per cent, with an increase in amount paid as wages of $659,920, or 135 per cent.

PRODUCT OF SOUTH CAROLINA PHOSPHATE ROCK IN THE CENSUS YEARS 1889 AND 1880.

| YEARS. | Number of establishments. | Tons of phosphate rock mined. | Value. | NUMBER OF HANDS EMPLOYED. | | Amount paid in wages. | Capital invested. |
|---|---|---|---|---|---|---|---|
| | | | | Males over 16 years. | Males under 16 years. | | |
| 1889 | 25 | 541, 645 | $2, 892, 276 | 4, 842 | 90 | $1, 149, 967 | $5, 866, 718 |
| 1880 | 21 | 211, 377 | 1, 123, 823 | 2, 405 | 70 | 490, 047 | 2, 071, 300 |
| Increase | 4 | 330, 268 | 1, 768, 453 | 2, 437 | 20 | 659, 920 | 3, 795, 418 |
| Percentage of increase | 19 | 156 | 157 | 101 | 29 | 135 | 183 |

The following table gives the number of persons employed in phosphate-rock mining in the state of South Carolina, together with the average wages per day of each class and the average number of days employed:

LABOR EMPLOYED IN PHOSPHATE-ROCK MINING IN SOUTH CAROLINA IN 1889.

| DISTRIBUTION. | Number. | Average wages per day. | Average number of days employed. |
|---|---|---|---|
| Total | 4, 932 | | |
| Foremen | 106 | $2. 23 | 242 |
| Mechanics | 128 | 2. 51 | 248 |
| Laborers | 4, 608 | 0. 97 | 225 |
| Boys under 16 years | 90 | 0. 51 | 161 |

OPERATING EXPENSES.

| | |
|---|---|
| Wages (including office force at mines) | $1, 190, 622 |
| Paid contractors | 115, 430 |
| Paid for supplies | 313, 359 |
| Paid for other expenditures | 342, 648 |
| Total | 1, 962, 059 |

The phosphate trade in South Carolina is greatly stimulated by the favorable location of the beds in respect to the field of greatest consumption, namely, the southern states, which annually consume about 375,000 tons of commercial fertilizers. This in great measure prevents the foreign article from becoming a serious competitor, and in proportion increases trade throughout the state. Another stimulant to trade is the fact that large quantities of phosphate are shipped to various ports as ballast under cotton. Thus cheap transportation is secured, and in proportion the cost of the fertilizer is lessened to the consumer. The rock is especially adapted for the manufacture of commercial fertilizers, it being remarkably free from gangue rock and other impurities, and is readily ground to the necessary fineness for complete decomposition by sulphuric acid. Kiln-dried rock constitutes more than half of the phosphate now delivered for manufacture in the state of South Carolina.

## ROYALTIES.

In 1870 the legislature of South Carolina imposed a royalty of $1 per ton on all phosphate rock taken from the navigable streams of the state. The royalty thus exacted has proved a most important feeder to the state's treasury, the amount obtained from this source up to and including 1889 exceeding the sum of $2,000,000.

The following table shows the distribution, by years, of the sum thus obtained from 1870 to 1889, inclusive:

AMOUNT OF ROYALTY REALIZED BY THE STATE OF SOUTH CAROLINA FROM PHOSPHATE MINING, 1870 TO 1889, INCLUSIVE.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1870 | $1, 989 | 1876 | $81, 912 | 1882 | $140, 772 | 1887 | $208, 772 |
| 1871 | 17, 655 | 1877 | 126, 569 | 1883 | 125, 793 | 1888 | 186, 994 |
| 1872 | 22, 502 | 1878 | 97, 700 | 1884 | 153, 798 | 1889 | 212, 102 |
| 1873 | 45, 777 | 1879 | 98, 586 | 1885 | 176, 755 | | |
| 1874 | 57, 716 | 1880 | 65, 314 | 1886 | 196, 090 | Total | 2, 199, 320 |
| 1875 | 57, 969 | 1881 | 124, 555 | | | | |

## PRICES.

The price of kiln-dried land rock varied in 1889 from $6 per ton (free on board vessel) in January to $6.75 in December. Ground rock, which is about 99 per cent of land rock, averaged $8 per ton (free on board vessel) for the first 5 months of the year and then advanced to $8.50, which was the closing quotation for the year. Sales free on board cars were nearly uniform at $7.75. Kiln-dried river rock was worth $5.50 (free on board vessel) in January; in June the price had advanced to $6.50, and in December offers of $7.75 per ton were made for a cargo for foreign shipment. Compared with 1888, the figures show a general increase in price except in December, 1889, when there was a decrease of 25 cents per ton compared with the same month in 1888. Land rock sold in January, 1888, at $4 per ton for crude and $5 for kiln-dried; in August the price advanced to $5 and $6 for crude and kiln-dried, respectively, and these figures prevailed to the close of the year. River rock opened at $4 and $5, respectively, for crude and dried, and advanced to $4.75 and $5.75, and so continued throughout the year. Ground rock was worth $6.50 per ton at the beginning of the year, advancing from this figure to $7.50 in August to $8 in December.

The following table shows the shipments of crude phosphate rock from the cities of Beaufort and Charleston from the year 1867, when it first became an industry, to 1889, together with the amount of local consumption for the same period at those places. It will be seen that the shipments to foreign ports for the year 1889 from Beaufort were 137,102, against 185,850 tons in 1888, showing a decrease of 48,748 tons. The domestic shipments for 1889 were 60,000 tons, against 29,834 tons for 1888, an increase of 30,166 tons, while there was an increase in the local consumption of 3,000 tons. The foreign shipments from Charleston for 1888 were 3,800 tons, for 1889 5,900 tons, giving an increase of 2,100 tons. The domestic shipments for 1888 were 208,000 tons, against 248,643 tons for 1889, showing an increase over the preceding year of 40,643 tons, while the local consumption at Charleston is reported as 75,000 tons, being the largest amount recorded to the close of the calendar year 1889.

The total foreign shipments for the years from 1867 to 1889, inclusive, are given as 2,003,487 tons; domestic shipments, 2,433,217 tons; local consumption, 741,047 tons; making a grand total of 5,177,751 tons, with a value of $33,000,000.

### SHIPMENTS AND CONSUMPTION OF CRUDE PHOSPHATE AT BEAUFORT AND CHARLESTON, 1867 TO 1889, INCLUSIVE.

[Long tons.]

| YEARS. | BEAUFORT. | | | CHARLESTON. | | |
|---|---|---|---|---|---|---|
| | Foreign ports. | Domestic ports. | Consumption. | Foreign ports. | Domestic ports. | Consumption. |
| Total | 1,689,802 | 423,804 | 66,900 | 313,685 | 2,009,413 | 674,147 |
| 1867 | ... | ... | ... | ... | 6 | ... |
| 1868 | ... | ... | ... | 208 | 11,654 | ... |
| 1869 | ... | ... | ... | 3,760 | 24,511 | ... |
| 1870 | 1,980 | 664 | ... | 13,652 | 40,099 | ... |
| 1871 | 28,431 | 5,064 | ... | 14,093 | 16,843 | 12,000 |
| 1872 | 17,540 | 3,180 | ... | 15,628 | 25,955 | 10,000 |
| 1873 | 24,600 | 4,765 | ... | 2,435 | 27,403 | 15,000 |
| 1874 | 44,857 | 10,500 | ... | 7,688 | 31,930 | 16,000 |
| 1875 | 44,617 | 7,000 | ... | 25,929 | 25,560 | 19,680 |
| 1876 | 50,834 | 9,400 | ... | 25,431 | 28,831 | 18,850 |
| 1877 | 73,923 | 6,285 | ... | 28,844 | 40,768 | 15,000 |
| 1878 | 100,619 | 8,217 | ... | 21,123 | 60,729 | 17,635 |
| 1879 | 97,799 | 8,618 | ... | 21,767 | 52,281 | 18,900 |
| 1880 | 47,157 | 13,346 | ... | 14,218 | 94,012 | 22,040 |
| 1881 | 62,600 | 65,895 | ... | 8,568 | 91,929 | 38,142 |
| 1882 | 89,581 | 57,645 | ... | 22,905 | 111,314 | 42,900 |
| 1883 | 94,789 | 36,175 | ... | 28,251 | 150,545 | 42,000 |
| 1884 | 132,114 | 34,711 | 5,900 | 21,495 | 187,700 | 51,000 |
| 1885 | 112,000 | 32,000 | 12,000 | 11,490 | 161,700 | 55,000 |
| 1886 | 153,409 | 14,600 | 9,000 | 6,800 | 187,000 | 60,000 |
| 1887 | 190,000 | 15,905 | 13,000 | 9,700 | 182,000 | 70,000 |
| 1888 | 185,850 | 29,834 | 12,000 | 3,800 | 208,000 | 75,000 |
| 1889 | 137,102 | 60,000 | 15,000 | 5,900 | 248,643 | 75,000 |

### RECAPITULATION.

[Long tons.]

| PORTS OF SHIPMENT. | To foreign ports. | To domestic ports. | Local consumption. | Total. | Value. |
|---|---|---|---|---|---|
| Total | 2,003,487 | 2,433,217 | 741,047 | 5,177,751 | $33,000,000 |
| Beaufort | 1,689,802 | 423,804 | 66,900 | 2,180,506 | 13,500,000 |
| Charleston | 313,685 | 2,009,413 | 674,147 | 2,997,245 | 19,500,000 |

The question of the supply of phosphate rock from the river and land beds in the future has been discussed at different times by various authorities, who have attempted to estimate the tonnage available for commercial mining; but these estimates vary so widely as to destroy the value of any conclusions based on them. Professor C. U. Shepard, jr., put the figure at 5,000,000 tons; Professor Otto W. Moses at 9,000,000 tons, and Professor H. Colton's estimate is 576,000,000 tons. The first of these estimates has already been exceeded; the second has not yet been reached, and it is doubtful if the last will ever be.

## FLORIDA.

The occurrence of phosphate rock of low grade in this state has been known since 1883, when noticed by Professor Lawrence C. Johnson, but in 1888 discoveries were made of deposits of large extent and high in their percentage of phosphoric acid. These deposits have continued to attract attention, have been the scene of speculation, and have been developed with great rapidity and enterprise.

### DISCOVERIES PRIOR TO 1888.

It was known in 1882 that phosphate deposits could be found following an irregular line from Thomasville, Georgia, down through Hamilton, Suwannee, Alachua, Marion, Sumter, and Polk counties, disappearing in Manatee county, in the region of Charlotte harbor. They had been noticed more particularly from Live Oak, Suwannee county, to Ocala, Marion county, and attention had been paid only to this region. The region north has been traced by popular report, not by careful survey. These deposits are in high land, and the line of phosphates is generally coincident with the upper part of a ridge running approximately north and south. Commencing with the upper limits of the deposit it is impossible to say how much of the rock is really phosphatic and how much is Vicksburg limestone, with which it has been confused. From Live Oak to Ocala there is little of the limestone, but the phosphate rock is very abundant. It is usually a very porous rock, containing through its mass the bones and teeth of various vertebrates. In badly drained spots it is wet and then soft, so that it is easily broken, but on drying it becomes so much harder that it is valued as a building stone, and has been so much used for chimneys and underpinning for houses that it is known as "chimney rock". The ridge with its phosphate deposits skirts the great region of depression, which includes the sinks of Alachua county. 3 miles north of Waldo, in this county, there is a large dry sink in which Mr. John A. Preston found phosphate rock containing 25 per cent of phosphoric acid at a depth of 50 to 75 feet. At Fort Harley, near by, deposits have also been found, and again on the borders of Santa Fe lake. The Devil's Millhopper is another sink, about 5 miles west of Gainesville, which contains quantities of loose bowlders of phosphate rock. Near it is a large quarry of building rock, also phosphatic. 3 miles west of Hawthorne there is a deposit of 35 to 50 acres, called Simmons Quarry, from which samples have been taken showing 45 per cent of calcium phosphate. Similar deposits have been described near Newnansville. Little attention has been paid to these deposits, although in 1883 Dr. C. A. Simmons, of Hawthorne, began quarrying the rock and converting it into a fertilizer. Many other isolated deposits had been noticed in the state before attention was prominently called to Florida by the developments of 1888. Among such deposits was one passed through in digging the pump well for the Jacksonville waterworks. At a depth of 20 feet a thin layer of greenish marl containing considerable phosphate was observed.

In 1886 phosphate rock of high grade was discovered on the Peace river. The Arcadia Phosphate Company has made extensive developments on rock there exposed in the river bed. A permanent bridge has been built, and drying kilns, hoisting machinery, and screens are in operation. In 1888 the company began shipments, which amounted to 3,000 tons. The richest rock is in the form of coarse sand from the river bar.

### RECENT DISCOVERIES.

The year 1888 also developed an entirely different class of phosphate deposits, of undoubtedly great value to the state, and which have attracted attention in all parts of the United States, and even in Europe. At the close of 1888, Mr. Albertus Vogt, living near Dunnellon, a village on the Withlacoochee river, in Marion county, found fossil teeth in a white subsoil. Some of this white soil was submitted to a chemist for analysis, and found to contain a large proportion of phosphate of lime. This soil was soon found to extend in a more or less pockety belt over a district some 30 miles long and 6 wide. Active exploration began at once and extended rapidly, with the usual speculative excitement of such discoveries. The fact is well established that much of the material is of unusually high grade, the highest in the United States. This developmental and speculative work was the main feature of the census year.

The following table shows the expenditures made in regular mining:

STATISTICS OF PHOSPHATE MINING IN FLORIDA IN 1889.

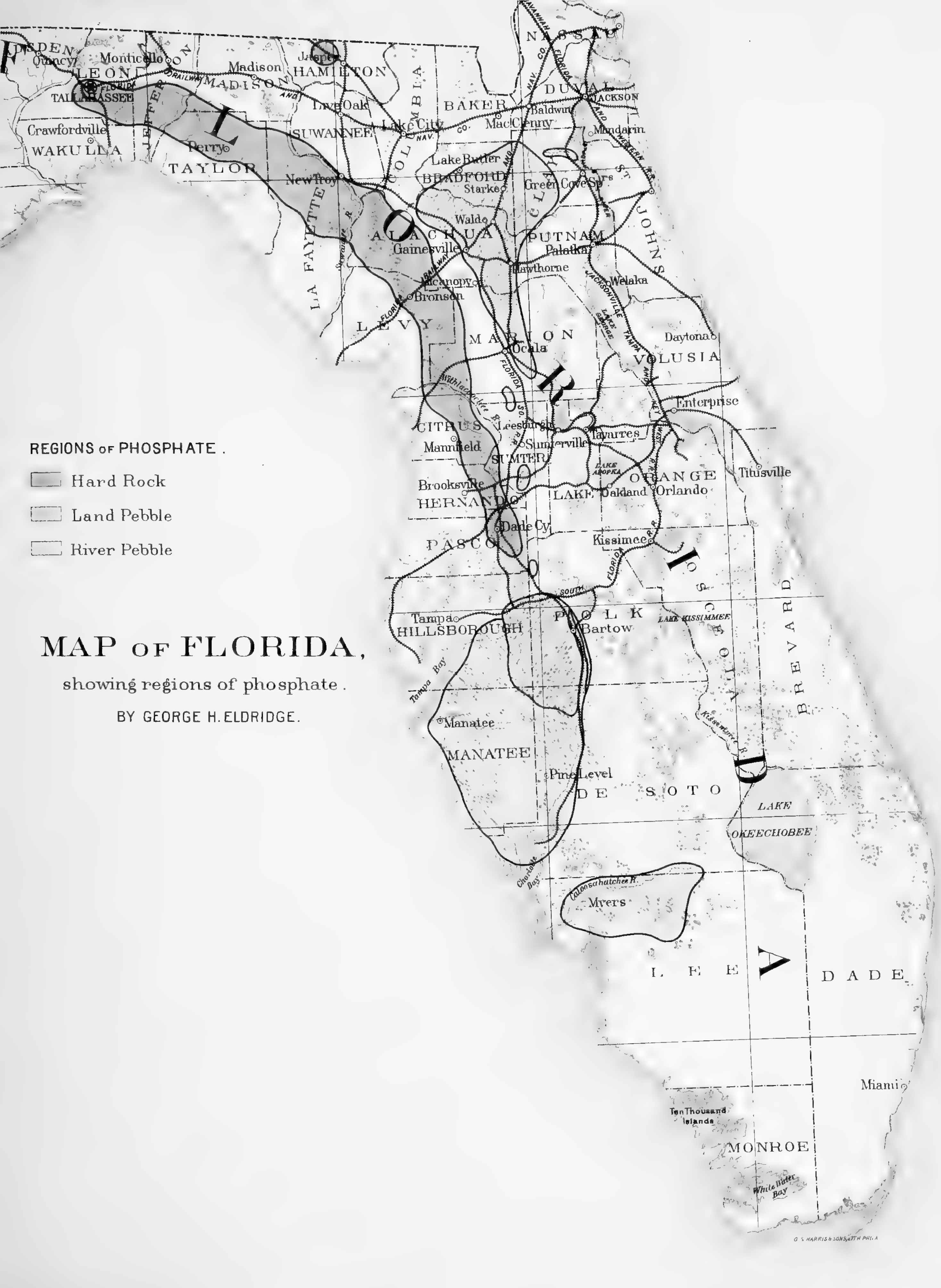
| | |
|---|---|
| Total phosphate rock produced (long tons) | 8,100 |
| Total phosphate rock sold (long tons) | 4,100 |
| Stock on hand January 1, 1890 (long tons) | 4,000 |
| Total value of product | $40,500 |
| Expenditures: | |
| Total wages (including office force at mines) | $17,404 |
| Paid for supplies | 1,800 |
| Paid for other expenditures | 523 |
| Total | 19,727 |
| Capital invested: | |
| In land | $130,000 |
| In buildings | 22,000 |
| In tools and machinery | 8,000 |
| Cash | 5,000 |
| Total | 165,000 |

LABOR EMPLOYED.

| EMPLOYÉS. | Number. | Average rate of wages per day. | Average number of days employed. |
|---|---|---|---|
| Total | 64 | | |
| Foremen | 4 | $2.25 | 250 |
| Mechanics | 2 | 1.75 | 200 |
| Laborers | 57 | 1.25 | 205 |
| Boys | 1 | 0.75 | 90 |

Florida phosphates may be divided into 4 classes, namely, the hard rock, the soft rock, the land pebble, and the river pebble.

Of the hard rock phosphate there are certain local variations: the massive rock itself; the laminated rock, in which there are narrow layers of phosphate separated by the equally narrow interspaces, and the plate phosphate, which is probably derived from the laminated variety, and is thus far found only in one or two localities in Florida in the more recent deposits. The hard rock phosphate is white, creamy, gray, or yellowish-brown in color, and varies in texture and structure from one of homogeneous appearance to a brecciated variety and to still others carrying considerable sand and clay. It is sometimes stained in a slight degree with iron, and always contains more or less alumina. The percentage of phosphate of lime contained in this class of rock is between 80 and 86. The extent of the hard rock phosphate as thus far developed is from a point about south of Tallahassee, following the line of the gulf at a distance of from 20 to 30 miles, around to a little below Dade City, in peninsular Florida. Its length is a little less than 200 miles. The deposit is not continuous, but may occur at any point within its length. It also extends into the north of Florida quite to the Georgia line, in the vicinity of the Suwannee river. The width of the belt is between 6 and 10 miles. Mining is by open pits, and in the case of the older and better organized companies is conducted with the most approved plants. The character of the occurrence of the hard rock phosphate has not been altogether satisfactorily determined, but the evidence is in favor of a mass or masses of bowlders piled together over areas of greater or less extent. The actual depth of any of these piles has not been determined, the greatest depth yet reached being about 60 feet from the surface. From an inspection of the deposits one would be led to think that their materials have not been transported far from the beds of which they originally formed a part. Hard rock phosphate bowlders have been derived from rocks of two geological ages, one eocene, which has the widest areal distribution, and the other, miocene, which is found within the so-far comparatively limited area southeast of Tallahassee. In the vicinity of Dunnellon, where the hard rock region is crossed by the Withlacoochee river, the phosphate has been broken down, and is now dredged from the bottom of the stream in a form somewhat altered from its original condition, or as pebbles. Vertebrate remains occur in abundance. Hard rock phosphate has also been mined near Boston, Georgia, a station on the line of the Savannah, Florida and Western railroad, just north of the Florida boundary.



MAP OF FLORIDA,
showing regions of phosphate.
BY GEORGE H. ELDRIDGE.

G. S. HARRIS & SONS, LITH PHILA.

ANALYSIS OF PHOSPHATE ROCK FROM LURAVILLE, FLORIDA.

| | PER CENT. |
|---|---|
| Phosphoric acid, $P_2O_5$ | 33.91 |
| Lime, CaO | 47.02 |
| Alumina, $Al_2O_3$ | 2.37 |
| Ferric oxide, $Fe_2O_3$ | 1.46 |
| Magnesia, MgO | 0.39 |
| Alkalies, $Na_2O$ | 0.19 |
| Sulphuric acid, $SO_3$ | 0.36 |
| Fluorine, Fl | 2.35 |
| Chlorine, Cl | 0.08 |
| Silica (dissolve), $SiO_2$ | 0.10 |
| Carbonic acid | 2.67 |
| Insoluble matter | 5.07 |
| Water at 105° | 1.18 |
| Water at red heat | 2.78 |
| | 99.93 |

The soft rock phosphate occurs both as a deposit by itself and in the deposits of hard rock, filling the spaces between the bowlders. It may be either clayey or sandy in its nature. It falls considerably below the hard rock in the percentage of phosphate of lime, and naturally shows a higher percentage.

The land pebble phosphate is found in a number of localities in peninsular Florida, the center of production at present being in Polk county, within a radius of 18 miles of Bartow. Thus far it has been worked only to the west of Peace river, within 12 or 15 miles of it, but prospectors have reported its occurrence beneath a large part of the surface between Peace river and the Gulf. It is essentially a mass of white phosphate pebbles lying in a matrix of phosphatic clay or sand, usually a combination of the two. The matrix is easily disintegrated by water and the pebbles are washed out by appropriate machinery. The pebbles vary in size from grains to 1 inch in diameter, the average being between one-quarter and one-half an inch. They are hard, and usually pure white or cream colored on fresh fracture. The percentage of phosphate which they contain is between 75 and 80 per cent, but the yield of the rock as mined would not reach this standard, in fact falls considerably below it. The land pebble is found in several parts of Florida; in the vicinity of Bartow; in connection with the plate rock at Anthony and Sparr, 10 miles north of Ocala, and again northeast of Gainesville, occupying here an extensive area. The age of the land pebble deposits is probably older pliocene. The methods of mining the land pebble are being rapidly developed, the most complete plant being that of the English Company, 7 miles south of Bartow, where, under the favorable condition existing, enormous basins have been dug in which dredges of great capacity are floated. The pebble is dredged, washed by machines adapted to the purpose, dried, and then shipped.

The river pebble is found in bars in the rivers of southern Florida, the greatest production at present being the Peace river, which furnishes nearly the entire product. The other rivers in southern Florida that are known to carry river pebble in quantity are the Alafia, the two Manatees, and the Caloosahatchee; in northeast Florida, Black creek, a tributary to the Saint Johns, which enters the latter stream about 20 miles south of Jacksonville, also yields a small amount. Pebble phosphates are also found in many other streams entering the Gulf, but thus far not in workable quantities. With the pebbles are often found the remains of vertebrate animals. The river pebble is blue or black in color, of a size from 1 inch down, usually finer as distance down stream is gained. It occurs as pebbles, or more rarely as the hardened casts of small mollusks, which show some attrition by water. In the Caloosahatchee the pebble is mixed with ordinary shells of carbonate of lime washed out from the pliocene and postpliocene beds bordering the river above. The derivation of the river pebble is probably very largely from the land pebble deposits, the streams in which they occur draining the country occupied by these deposits. Some of them may also have been derived from the hard rock phosphate. The percentage of phosphate of lime in the river pebble is between 58 and 68 per cent, the average of the cargoes running between 60 and 65 per cent. The river pebble is dredged, washed, and floated on the river to the works, where it is then dried, cleaned, and made ready for shipment. The phosphate-drying works are very extensive.

## NORTH CAROLINA.

Phosphates have been known to exist in the state of North Carolina for a number of years, but it was not until 1884 that they were fully examined. In that year Professor Charles W. Dabney, jr., of the state geological survey, made a thorough investigation and examination, and found them to be of 2 classes. First, amorphous nodules, very much resembling those of South Carolina, and, second, conglomerates, in which the pebbles are phosphate and the matrix a white calcareous rock. The first are of poor quality, occurring in small quantities, varying widely in quality of chemical constituents, and commercially of little value. Their locality is principally in the southern and southeastern portions of the state, in the counties of Sampson, Pender, Onslow, Duplin, Columbus, and New Hanover. In shape the nodules are flat, in this respect differing from those of South Carolina, which appear to have no definite form.

The phosphatic conglomerates consist of a mass of tertiary teeth, bones, nodules, and quartz pebbles, in connection with grains of greensand, with which they are cemented together in a calcareous matrix. These conglomerates are found principally in New Hanover and Pender counties. They exist in beds from 1 to 6 feet in depth. As the depth increases they grow smaller in size. The largest scarcely exceed in size an ordinary walnut, but at the greatest depth the smallest are of the dimension of a buckshot. The whole mass of conglomerate does not contain over 10 to 20 per cent of phosphate of lime. It has been ground by several companies in the state, by whom it is sold to local consumers, who have used it with some success as a fertilizer.

STATISTICS OF PRODUCTION OF PHOSPHATE ROCK IN NORTH CAROLINA.

| | |
|---|---|
| Total product (short tons) | 500 |
| Total value | $5, 000 |
| Employés: | |
| Laborers (number) | 15 |
| Average rate of wages | $0. 75 |
| Average number of days employed | 100 |
| Expenditures: | |
| Total wages paid | $1, 125 |
| Paid contractors | 500 |
| Paid for supplies | 2, 000 |
| Paid for other expenditures | 100 |
| Total | 3, 725 |
| Capital invested: | |
| In land | $90, 000 |
| In buildings and fixtures | 5, 000 |
| In tools and machinery | 5, 000 |
| Total capital | 100, 000 |
| Power: | |
| Steam boilers (total 50 horse power) | 2 |
| Steam engine (15-inch cylinder) | 1 |
| Horses employed | 3 |

## ALABAMA.

In Alabama there is a belt running across the state from east to west just below its middle, and included between parallels of latitude 32° and 33°, locally known as the "black belt". In this belt, particularly in the central and western parts, greensand marls and phosphatic nodules have been found, which promise fully as well as the Florida phosphates did a few years ago. Some effort has been made to develop these deposits, and the phosphatic marls particularly have been used locally, but the district is not well supplied with transportation facilities at present. The northern boundary is a line drawn from Columbus, Georgia, westward through Tuskegee, Montgomery, Marion, Greensboro, and Eutaw, Alabama, on to Columbus, Mississippi. The belt extends southward from this line for 20 to 50 miles. In the eastern parts of the state it is covered by the drift to such a depth as to be practically useless. In the central and western part of the state the belt is well exposed. Under a stratum of green sand marl 5 to 6 feet thick occurs a sandy, indurated nodular rock 2 feet thick, cemented by carbonate of lime, which yields from 200 to 800 tons per acre of phosphatic nodules, yielding 20 to 38 per cent of phosphoric acid.

As soon as the approaching era begins of fertilizing by the application of calcined phosphates directly to the land, these deposits will be great sources of wealth, and a region now little known will in due time be very valuable. No work was done on these deposits in 1889.

## STATISTICS OF PHOSPHATE ROCK PRODUCTION IN THE UNITED STATES IN 1889.

### AMOUNT AND VALUE OF PHOSPHATE ROCK PRODUCED IN 1889.

[Long tons.]

| STATES. | Amount produced. | Amount sold. | Value of product. |
|---|---|---|---|
| Total | 550, 245 | 547, 609 | $2, 937, 776 |
| South Carolina | 541, 645 | 543, 009 | 2, 892, 276 |
| Florida | 8, 100 | 4, 100 | 40, 500 |
| North Carolina | 500 | 500 | 5, 000 |

### LABOR AND WAGES.

| STATES. | FOREMEN. | | | MECHANICS. | | | LABORERS. | | | BOYS UNDER 16 YEARS. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number. | Average wages per day. | Average number of days employed. | Number. | Average wages per day. | Average number of days employed. | Number. | Average wages per day. | Average number of days employed. | Number. | Average wages per day. | Average number of days employed. |
| Total | 110 | $2. 23 | 242 | 130 | $2. 50 | 247 | 4, 680 | $0. 97 | 224 | 91 | $0. 51 | 160 |
| South Carolina | 106 | 2. 23 | 242 | 128 | 2. 51 | 248 | 4, 608 | 0. 97 | 225 | 90 | 0. 51 | 161 |
| Florida | 4 | 2. 25 | 250 | 2 | 1. 75 | 200 | 57 | 1. 25 | 205 | 1 | 0. 75 | 90 |
| North Carolina | ........ | ........ | ........ | ........ | ........ | ........ | 15 | 0. 75 | 100 | ........ | ........ | ........ |

### OPERATING EXPENSES.

| STATES. | Total expenditures. | Wages, including office force. | Paid contractors. | Paid for supplies. | Other expenditures. |
|---|---|---|---|---|---|
| Total | 1, 985, 511 | 1, 209, 151 | 115, 930 | 317, 159 | 343, 271 |
| South Carolina | 1, 962, 059 | 1, 190, 622 | 115, 430 | 313, 359 | 342, 648 |
| Florida | 19, 727 | 17, 404 | ........ | 1, 800 | 523 |
| North Carolina | 3, 725 | 1, 125 | 500 | 2, 000 | 100 |

## CANADIAN APATITE.

The supply of Canadian apatite comes from the vicinity of Ottawa, Perth, and Kingston, but it is to be found in varying quantities throughout the Laurentian chain of mountains. It is mined by regular companies in many instances, but in others by farmers during time otherwise unoccupied at their agricultural pursuits. It is generally discovered in irregular veins or in pockets, in connection with feldspar, gneiss, limestone, mica, and other rocks, which appear on the surface or penetrate deep into the soil. The apatite is separated by hand dressing, that is, simply breaking off the adhering rock by means of a common gavel or a hammer. This process is slow and, in proportion, expensive, and necessarily lessens the production. The difficulties of transportation are also great, much of the crude product being hauled over rough mountainous roads to water routes and railroads. It is not likely that the entire output of the region producing apatite will greatly exceed, under the most favorable circumstances, 20,000 tons per annum, with an average market value of $15 per ton.

Canadian apatite is easily crushed, but its pulverization is difficult, and it does not readily mix with acid in the manufacture of superphosphates. It contains a high amount of fluoride of calcium, and generates on treatment with sulphuric acid a large amount of hydrofluoric acid, thus requiring special arrangements in the works for ventilation because of the poisonous gases thrown off. Notwithstanding the impurities associated with it, Canadian apatite is sometimes obtained quite clean, and often with 70 to 80 per cent of bone phosphate of lime, and when intelligently handled will yield a superphosphate containing about 20 per cent soluble phosphoric acid.

# MARL.

# MARL.

BY JEFFERSON MIDDLETON.

The total product of marl in the United States at the Eleventh Census amounted to 139,522 long tons, valued at $63,956. The production is limited to 5 states, namely, New Jersey, North Carolina, Virginia, Alabama, and Arkansas. The production of the last 4 states is very small, being but 1,405 tons, with a value of $2,253.

At the Tenth Census no statistics in regard to marl were published. The production in New Jersey during the census year was 138,117 tons, valued at $61,723. The industry is conducted almost exclusively by farmers, there being but 3 organized companies engaged therein, and these produced only 10 per cent of the entire output during the period under review. The season during which marl is dug begins in October and ends about May 1, thus enabling the producers to work during the leisure time of winter.

The production during 1889–1890 was small as compared with other years, which was due in part to the mild and rainy weather which prevailed that winter, seriously affecting the condition of the roads and making hauling difficult. Further and more potent reasons, as stated in Mineral Resources of the United States, 1888, are the increased use of more easily applied manufactured fertilizers, and the general opinion that the effects of marl are comparatively lasting, and, the land having received a thorough application it is not necessary for some years to use it so extensively as was done in the early part of the last decade. During the period just referred to immense quantities of marl were used all over the state of New Jersey, in some years reaching nearly 1,000,000 tons, and many farmers think that the land has received so much marl that new applications have very little, if any, effect. The marl belt of the state extends from Raritan bay to the head of the Delaware bay, with an average width of from 10 to 14 miles, and marl is accessible on most of the farms situated within this belt. The only deposit in the state outside of the limits mentioned occurs in Cumberland county, in the neighborhood of Shiloh.

The methods of disposing of the marl are either to sell on the bank, ready for hauling, in which case the seller does the digging, or to sell the marl in place, the purchaser getting it out. Then, again, a farmer who has a pit on his premises takes out what he needs and puts it on his land, and in many cases no account is kept even of the quantity used. It will be readily seen that from the nature of the business accurate statistics of labor and wages are impossible to obtain, so in this particular industry no attempt has been made to tabulate the statistics, it being deemed sufficient to give the production and value.

As to the capital involved, the same condition of affairs exists, the large area of marl land making it impracticable to arrive at its value by the tests applied to other mineral deposits, for the reason that many farms having marl beds under them are at present more valuable for farming purposes than as mineral lands.

# GYPSUM.

# GYPSUM.

BY E. W. PARKER.

## PRODUCTION.

The amount of crude gypsum produced in the United States in 1889 was 267,769 short tons. The value ranges between 75 cents and $2 per ton, according to quality, but as only a small portion of the product is sold in its crude state it is deemed expedient to show how much of the total product was sold crude, how much was calcined into plaster of paris or stucco, how much was manufactured into cement, and the amount ground into fertilizer known as "land plaster", with the value of each. In each instance the number of men employed and the amount of wages paid represent the labor and expense required to bring the mineral to the condition for which the value is given; that is, the price at which it was first sold. The same may also be said of the statistics of the capital invested in the industry. The states and territories producing gypsum in 1889 were California, Colorado, Iowa, Kansas, Michigan, New York, Ohio, South Dakota, Utah, Virginia, and Wyoming, as shown in the following table:

PRODUCTION OF GYPSUM IN 1889, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | Total amount produced. (Short tons.) | Total value. | Amount sold in crude state. (Short tons.) | Value. | Amount sold as land plaster. (Short tons.) | Value. | Amount of gypsum calcined into plaster of paris or stucco. (Short tons.) | Amount of plaster of paris or stucco after calcining. (Short tons.) | Value. |
|---|---|---|---|---|---|---|---|---|---|
| Total | 267, 769 | $764, 118 | 73, 243 | $82, 704 | 108, 771 | $233, 307 | 85, 755 | 64, 711 | $448, 107 |
| California | 3, 000 | 30, 000 | | | | | 3, 000 | 2, 250 | 30, 000 |
| Colorado | 7, 700 | 28, 940 | | | 100 | 140 | 7, 600 | 4, 325 | 28, 800 |
| Iowa | 21, 784 | 55, 250 | | | 14, 434 | 23, 000 | 7, 350 | 5, 507 | 32, 250 |
| Kansas | 17, 332 | 94, 235 | | | | | 17, 332 | a13, 896 | 94, 235 |
| Michigan | 131, 767 | 373, 740 | 35, 100 | 35, 100 | 54, 084 | 123, 143 | 42, 583 | 32, 434 | 215, 497 |
| New York | 52, 608 | 79, 476 | 21, 537 | 21, 642 | 31, 071 | 57, 834 | | | |
| Ohio | 9, 920 | 51, 491 | 106 | 212 | 2, 744 | 9, 604 | 7, 070 | 5, 656 | 41, 675 |
| South Dakota | 320 | 2, 650 | | | | | 320 | 253 | 2, 650 |
| Utah | b16, 000 | 25, 000 | 16, 000 | 25, 000 | | | | | |
| Virginia | 6, 838 | 20, 336 | 500 | 750 | 6, 338 | 19, 586 | | | |
| Wyoming | c500 | 3, 000 | | | | | 500 | 390 | 3, 000 |

a Of the Kansas product 600 tons were made into fireproof cement, producing 400 tons of cement, valued at $6,000.

b Estimated, and value given for crude material.

c Began operations November 1, 1889.

## LABOR AND WAGES.

The highest rate of compensation to foremen above ground was $5 per day, paid at Iowa quarries; the lowest, $1 per day, paid in Virginia. The highest wages paid mechanics was paid in Colorado, $3 per day; the lowest, $1 per day, paid in Virginia. Ordinary labor above ground received as the highest pay $2 per day, and as the lowest 75 cents. The former rate was paid by one firm in New York state and by all operators in South Dakota, Wyoming, Colorado, and California. The lowest rate was paid in Virginia. About 77 per cent of the labor was employed above ground.

### LABOR EMPLOYED AT GYPSUM MINES IN 1889.

| EMPLOYÉS. | Average number employed. | Highest wages paid. | Lowest wages paid. | Average wages per day. | Average number of days worked. |
|---|---|---|---|---|---|
| Total | 761 | | | | |
| Above ground: | | | | | |
| Foremen | 35 | $5.00 | $1.00 | $2.54 | 236 |
| Mechanics | 84 | 3.00 | 1.00 | 1.96 | 225 |
| Laborers | 460 | 2.00 | 0.75 | 1.40 | 204 |
| Boys under 16 years of age | 7 | 0.75 | 0.44 | 0.50 | 144 |
| Below ground: | | | | | |
| Foremen | 11 | 3.00 | 1.00 | 1.82 | 195 |
| Miners | 67 | 3.00 | 0.75 | 1.44 | 186 |
| Laborers | 97 | 2.50 | 0.75 | 1.20 | 181 |

### OPERATING EXPENSES.

| | |
|---|---|
| Wages (including office force at mines or quarries) | $249,200 |
| Paid contractors | 10,031 |
| Paid for supplies | 128,854 |
| Paid for other expenditures | 45,262 |
| Total | 433,347 |

### CAPITAL INVESTED.

| | |
|---|---|
| In land | $1,513,250 |
| In buildings, machinery, etc | 540,610 |
| In tools, implements, live stock, etc | 318,080 |
| In cash (not reported in foregoing items) | 101,235 |
| Total | 2,473,175 |

## MOTIVE POWER.

There were 24 producers who used steam power at their works, in all 33 boilers, with an aggregate of 2,045 horse power. The number of animals employed during the year at gypsum works was 284.

### STATISTICS OF PRODUCTION OF GYPSUM IN THE UNITED STATES IN 1889, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | Total amount of gypsum produced. (Short tons.) | Value. | Total expenditures. | Wages, including office force at works. | Paid contractors. | Paid for supplies. | All other expenditures, including rent, taxes, insurance, etc. |
|---|---|---|---|---|---|---|---|
| Total | 267,769 | $764,118 | $433,347 | $249,200 | $10,031 | $128,854 | $45,262 |
| Colorado | 7,700 | 28,940 | 20,667 | 12,175 | 3,000 | 4,467 | 1,025 |
| Iowa | 21,784 | 55,250 | 26,218 | 11,668 | 3,050 | 8,000 | 3,500 |
| Kansas | 17,332 | 94,235 | 75,874 | 35,195 | 1,156 | 34,281 | 5,242 |
| Michigan | 131,767 | 373,740 | 200,931 | 107,078 | 1,700 | 66,706 | 25,447 |
| New York | 52,608 | 79,476 | 59,707 | 41,054 | | 11,055 | 7,598 |
| South Dakota | 320 | 2,650 | 4,670 | 3,570 | 1,000 | | 100 |
| Utah | 16,000 | 25,000 | 11,294 | 9,544 | | 1,000 | 750 |
| Virginia | 6,838 | 20,336 | 10,066 | 8,396 | 125 | 745 | 800 |
| Other states (*a*) | 13,420 | 84,491 | 23,920 | 20,520 | | 2,600 | 800 |

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*a* There are here grouped, in order that the business of individual establishments may not be disclosed to the public, California, Ohio, and Wyoming.

LABOR EMPLOYED IN GYPSUM MINES IN 1889, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | ABOVE GROUND. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked. | | | |
| | Foremen. | Mechanics. | Laborers. | Boys under 16 years. | Foremen. | Mechanics. | Laborers. | Boys under 16 years. | Foremen. | Mechanics. | Laborers. | Boys under 16 years. |
| Total | 35 | 84 | 460 | 7 | $2.53 | $1.97 | $1.40 | $0.50 | 235 | 222 | 201 | 144 |
| Colorado | 3 | 6 | 15 | .......... | 3.00 | 2.58 | 2.00 | .......... | 221 | 200 | 103 | .......... |
| Iowa | 3 | 6 | 50 | .......... | 2.83 | 2.38 | 1.50 | .......... | 151 | 61 | 138 | .......... |
| Kansas | 5 | 14 | 42 | .......... | 2.95 | 2.11 | 1.38 | .......... | 267 | 201 | 222 | .......... |
| Michigan | 10 | 39 | 131 | 1 | 2.65 | 1.88 | 1.38 | 0.50 | 310 | 270 | 266 | 150 |
| New York | 6 | 6 | 125 | 1 | 1.83 | 1.76 | 1.38 | 0.75 | 200 | 189 | 181 | 300 |
| South Dakota | 2 | .......... | 4 | .......... | 2.25 | .......... | 2.00 | .......... | 110 | .......... | 170 | .......... |
| Utah | 2 | .......... | 15 | .......... | 3.50 | .......... | 1.75 | .......... | 275 | .......... | 275 | .......... |
| Virginia | 2 | 5 | 33 | 4 | 1.25 | 1.20 | 0.80 | 0.44 | 64 | 163 | 86 | 115 |
| Other states (*a*) | 2 | 8 | 45 | 1 | 2.50 | 1.99 | 1.46 | 0.50 | 287 | 220 | 213 | 100 |

| STATES AND TERRITORIES. | BELOW GROUND. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | Average wages per day. | | | Average number of days worked. | | |
| | Foremen. | Miners. | Laborers. | Foremen. | Miners. | Laborers. | Foremen. | Miners. | Laborers. |
| Total | 11 | 67 | 97 | $1.82 | $1.44 | $1.20 | 195 | 186 | 181 |
| Colorado | .......... | 1 | 1 | .......... | 2.50 | 2.50 | .......... | 300 | 300 |
| Iowa | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... |
| Kansas | 3 | 8 | 16 | 2.00 | 1.31 | 1.38 | 204 | 180 | 285 |
| Michigan | 3 | 15 | 54 | 2.00 | 1.29 | 1.25 | 256 | 304 | 200 |
| New York | .......... | 15 | .......... | .......... | 1.80 | .......... | .......... | 174 | .......... |
| South Dakota | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... |
| Utah | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... | .......... |
| Virginia | 4 | 22 | 22 | 1.25 | 0.86 | 0.75 | 116 | 95 | 58 |
| Other states (*a*) | 1 | 6 | 4 | 3.00 | 3.00 | 2.00 | 300 | 240 | 150 |

*a* There are here grouped, in order that the business of individual establishments may not be disclosed to the public, California, Ohio, and Wyoming.

CAPITAL EMPLOYED IN GYPSUM PROPERTIES IN THE SEVERAL STATES AND TERRITORIES.

| STATES AND TERRITORIES. | Total. | In land. | In buildings, machinery, etc. | Tools, implements, etc. | Cash. |
|---|---|---|---|---|---|
| Total | $2,473,175 | $1,513,250 | $540,610 | $318,080 | $101,235 |
| Colorado | 147,600 | 60,000 | 58,500 | 21,100 | 8,000 |
| Iowa | 194,500 | 78,500 | 45,000 | 69,500 | 1,500 |
| Kansas | 512,860 | 359,000 | 63,000 | 67,010 | 23,850 |
| Michigan | 725,000 | 347,000 | 276,000 | 81,000 | 21,000 |
| New York | 177,095 | 102,050 | 32,300 | 18,860 | 23,885 |
| South Dakota | 5,500 | 1,000 | 2,000 | 2,500 | .......... |
| Utah | 150,000 | 100,000 | 30,000 | 20,000 | .......... |
| Virginia | 300,620 | 249,000 | 13,510 | 16,110 | 22,000 |
| Other states (*a*) | 260,000 | 216,700 | 20,300 | 22,000 | 1,000 |

*a* There are here grouped, in order that the business of individual establishments may not be disclosed to the public, California, Ohio, and Wyoming.

## CHARACTERISTICS OF THE INDUSTRY.

Taking the foregoing table of production, it will be noted that all the gypsum product of New York and Virginia has been sold either in a crude state or as land plaster. Although the returns show that 22,037 tons were sold crude, there are no evidences that it was used in any other way than as a fertilizer. The gypsum of New York state is intermingled intimately with slate, and for this reason is found to be more available for agricultural purposes than for calcination. It is understood that the gypsum of Virginia is adapted to the manufacture of plaster of paris, and the subject is being investigated with a view to operations if found profitable. It will be observed that while all of the gypsum produced in the eastern states is used as a fertilizer, nearly all of the western product, with the exception of that of Michigan and Iowa, is calcined. In Ohio, out of a total product of 9,920 short tons, 7,070 tons were made into plaster of paris. About 32 per cent of the Michigan and 34 per cent of the Iowa product was so disposed of, and practically all of the product of the other western states. During the present investigation inquiries were addressed to representative firms in different producing districts for the purpose of obtaining the percentage of loss in weight by the calcination of gypsum. In making land plaster there is practically no loss, the rock being ground in the condition as quarried. In no instances in the manufacture of land plaster has the loss amounted to more than 5 per cent, and even this was exceptional, the majority of producers reporting either no loss or a loss of from ½ to 1 per cent. In the calcining, loss percentages are reported in different producing districts as follows: Colorado, from 25 to 33.33 per cent; Iowa, from 21 to 30 per cent; Kansas, from 18 to 20 per cent; Michigan, from 20 to 25 per cent; Ohio, about 25 per cent; South Dakota, about 20 per cent; Wyoming, 22 per cent. No information was received in this respect from California or Utah. As the product of New York and Virginia is altogether consumed for land plaster, no losses are reported.

## ANALYSES.

Below are given some analyses of gypsum and calcined plaster from New York, Michigan, and Ohio:

ANALYSES OF GYPSUM IN ONONDAGA COUNTY, NEW YORK.

| | No. 1.<br>PER CENT. | No. 2.<br>PER CENT. |
|---|---|---|
| Calcium sulphate | 94.00 | 94.23 |
| Carbonate of magnesia | 3.00 | 2.65 |
| Carbonate of lime | 3.00 | 2.20 |
| Oxide of iron | | 0.92 |
| Total | 100.00 | 100.00 |

ANALYSIS OF MICHIGAN LAND PLASTER.

| | PER CENT. |
|---|---|
| Lime | 32.35 |
| Sulphuric acid | 46.38 |
| Water | 19.70 |
| Magnesia | 0.54 |
| Alumina | 0.60 |
| Insoluble residue | 0.91 |
| Total | 100.48 |

ANALYSES OF CALCINED PLASTER FROM OHIO.

| | No. 1.<br>PER CENT. | No. 2.<br>PER CENT. |
|---|---|---|
| Lime | 32.52 | 32.76 |
| Sulphuric acid | 45.56 | 46.20 |
| Water | 20.14 | 20.00 |
| Magnesia | 0.56 | 0.03 |
| Alumina | 0.16 | 0.29 |
| Insoluble residue | 0.68 | 0.46 |
| Total | 99.62 | 99.74 |

## PRODUCTION IN PREVIOUS YEARS.

There is a very marked difference between the reports of the United States geological survey on the production of gypsum for years prior to 1889 and the figures obtained for the Eleventh Census. The tonnage for 1889 is largely in excess of that reported for previous years, but the value is, in comparison, greatly reduced. The product for 1888 was estimated at 110,000 short tons, at an average price of $5 per ton; that of 1889 was 267,769 tons, valued at $764,118, or an average of about $2.85 per ton. There was no report on the production of gypsum compiled in the Tenth Census, and there are no reliable figures after that time and previous to 1885. Since 1885 the product has been estimated for the Mineral Resources of the United States, as shown in the following table:

PRODUCTION OF GYPSUM IN THE UNITED STATES FROM 1885 TO 1888, INCLUSIVE.

| YEARS. | Quantity. (Short tons.) | Value. |
|---|---|---|
| 1885 | 90,405 | $405,000 |
| 1886 | 95,250 | 428,625 |
| 1887 | 95,000 | 425,000 |
| 1888 | 110,000 | 550,000 |

## LOCALITIES.

The gypsum-producing belt of New York lies along the southern shore of Lake Ontario, and includes the counties of Madison, Onondaga, Cayuga, Ontario, Monroe, and Genesee. The gypsum beds of Virginia are located in the southwest corner of the state along the North Fork of the Holston river, in Smyth and Washington counties. Transportation facilities are obtained by the Norfolk and Western railroad, which has a branch running to Saltville, Washington county, the most important producing point.

The production of gypsum in Ohio is confined to one locality, viz, the station of Gypsum, Ottawa county, on the line of the Lake Shore and Michigan Southern railroad, about 10 miles west of the city of Sandusky. The product of these quarries is of great excellence and purity. The best of the stone goes into calcined plaster, while any that is "off color" or streaked with shale is ground into land plaster.

The amount of each product and its value from 1881 to 1889 is shown in the following table:

PRODUCTION OF CALCINED AND LAND PLASTER SOLD IN OHIO FROM 1881 TO 1889, INCLUSIVE.

| YEARS. | CALCINED PLASTER. | | | LAND PLASTER. | | |
|---|---|---|---|---|---|---|
| | Barrels, of 300 pounds. | Average price per barrel. | Total value. | Short tons. | Average price per ton. | Total value. |
| 1881 | 12, 409 | $1. 55 | $19, 234 | 3, 705 | $4. 35 | $16, 117 |
| 1882 | 16, 888 | 1. 46 | 24, 656 | 4, 404 | 4. 33 | 19, 069 |
| 1883 | 20, 919 | 1. 41 | 29, 496 | 4, 678 | 4. 15 | 19, 414 |
| 1884 | 20, 307 | 1. 38 | 28, 024 | 4, 217 | 4. 09 | 17, 248 |
| 1885 | *a*8, 686 | 1. 31 | 11, 379 | 4, 038 | 4. 03 | 16, 273 |
| 1886 | 21, 256 | 1. 29 | 27, 420 | 4, 186 | 3. 87 | 16, 200 |
| 1887 | 21, 981 | 1. 28 | 28, 136 | 4, 098 | 3. 87 | 15, 859 |
| 1888 | 29, 876 | 1. 21 | 36, 150 | 4, 116 | 3. 91 | 16, 094 |
| 1889 | 41, 675 | 1. 00 | 41, 675 | *b*2, 744 | 3. 50 | 9, 604 |

*a* Small production in 1885, due to rebuilding of the works.

*b* In addition to this there were 106 tons sold crude to fertilizer companies at $2 per ton.

The producing localities in Michigan continue the same as reported for previous years in the Mineral Resources of the United States, but the census returns show a decided increase in production over that of any previous year. The total product for the state of Michigan alone in 1889 was 131,767 short tons. The table following shows the production of land plaster and stucco in Michigan up to and including 1887. No report of the product of 1888 has been published.

AMOUNT OF LAND PLASTER AND STUCCO PRODUCED IN MICHIGAN.

| YEARS. | Land plaster. (Short tons.) | Stucco. (Barrels, of 300 pounds.) |
|---|---|---|
| Previous to 1866 | 100, 000 | |
| 1866 | 14, 604 | |
| 1867 | 17, 439 | |
| Previous to 1868 | | *a*80, 000 |
| 1868 | 28, 837 | 34, 966 |
| 1869 | 29, 996 | 41, 187 |
| 1870 | 31, 437 | 46, 179 |
| 1871 | 41, 126 | 48, 685 |
| 1872 | 43, 536 | 59, 767 |
| 1873 | 44, 972 | 82, 453 |
| 1874 | 39, 126 | 82, 449 |
| 1875 | 27, 019 | 61, 120 |
| 1876 | *a*39, 131 | 64, 386 |
| 1877 | *a*40, 000 | *a*55, 000 |
| 1878 | 40, 000 | 48, 346 |
| 1879 | 43, 658 | 50, 800 |
| 1880 | 49, 570 | 106, 004 |
| 1881 | 33, 178 | 112, 813 |
| 1882 | 37, 821 | 135, 165 |
| 1883 | 33, 227 | 201, 133 |
| 1884 | 27, 888 | 156, 677 |
| 1885 | 28, 184 | 141, 575 |
| 1886 | 29, 378 | 153, 274 |
| 1887 | 28, 794 | 170, 107 |

*a* Estimated.

The Iowa gypsum beds lie along the Des Moines river, in Webster county. All the operators have their headquarters at Fort Dodge, near which town the deposits are located.

The counties producing gypsum in Kansas are Saline, Barber, Marshall, Sedgwick, and Dickinson. There have been no previous reports on the production of gypsum in Kansas. The returns from the census inquiries show a total product for the year 1889 of 17,332 short tons, valued in its first merchantable condition at $94,235. All of the product was calcined and sold as plaster of paris or stucco.

The gypsum localities of South Dakota are in Lawrence county. Work was just begun on these mines in 1889, and the product was 320 tons, all of which was made into plaster of paris.

The producing point in California is in Santa Barbara county, near the town of Guadaloupe. The mineral produced here is of excellent quality and of a good white color. The beds are but a short distance from a steamboat landing, and the product is delivered in San Francisco or other ports along the coast at very little expense for transportation. Gypsum is found in a number of other places in California, notably in Nevada, Stanislaus, Kern, San Luis Obispo, San Diego, Monterey, Ventura, and Tulare counties. The Santa Barbara deposits, however, furnish the supply for the market.

In Colorado large deposits exist in the counties of Jefferson, Larimer, and El Paso. The beds that have so far been worked are in the neighborhood of Big Thompson, Larimer county, and Colorado Springs, El Paso county.

GYPSUM IMPORTED INTO THE UNITED STATES FROM 1867 TO 1889, INCLUSIVE.

| YEARS ENDED— | Total. | GROUND OR CALCINED. | | UNGROUND. | | Value of manufactured plaster of paris. |
|---|---|---|---|---|---|---|
| | | Quantity. (Long tons.) | Value. | Quantity. (Long tons.) | Value. | |
| June 30, 1867 | $125,281 | ............ | $29,895 | 97,951 | $95,386 | ............ |
| 1868 | 114,350 | ............ | 33,988 | 87,694 | 80,362 | ............ |
| 1869 | 186,512 | ............ | 52,238 | 137,039 | 133,430 | $844 |
| 1870 | 148,720 | ............ | 46,872 | 107,237 | 100,416 | 1,432 |
| 1871 | 154,013 | ............ | 64,465 | 100,400 | 88,256 | 1,292 |
| 1872 | 168,873 | ............ | 66,418 | 95,339 | 99,902 | 2,553 |
| 1873 | 165,459 | ............ | 35,628 | 118,926 | 122,495 | 7,336 |
| 1874 | 170,901 | ............ | 36,410 | 123,717 | 130,172 | 4,319 |
| 1875 | 171,096 | ............ | 52,155 | 93,772 | 115,664 | 3,277 |
| 1876 | 179,070 | ............ | 47,588 | 139,713 | 127,084 | 4,398 |
| 1877 | 162,917 | ............ | 49,445 | 97,656 | 105,629 | 7,843 |
| 1878 | 140,587 | ............ | 33,496 | 89,239 | 100,102 | 6,989 |
| 1879 | 125,542 | ............ | 18,339 | 96,963 | 99,027 | 8,176 |
| 1880 | 150,409 | ............ | 17,074 | 120,327 | 120,642 | 12,693 |
| 1881 | 171,724 | ............ | 24,915 | 128,607 | 128,107 | 18,702 |
| 1882 | 200,922 | 5,737 | 53,478 | 128,382 | 127,067 | 20,377 |
| 1883 | 218,969 | 4,291 | 44,118 | 157,851 | 152,982 | *a*21,869 |
| 1884 | 210,904 | 4,996 | 42,904 | 166,310 | 168,000 | ............ |
| 1885 | 173,752 | 6,418 | 54,208 | 117,161 | 119,544 | ............ |
| 1886 | 153,338 | 5,911 | 37,642 | 122,270 | 115,696 | ............ |
| 1887 | 195,890 | 4,814 | 33,736 | 146,708 | 162,154 | ............ |
| Dec. 31, 1888 | 190,787 | 3,340 | 20,764 | 156,697 | 170,023 | ............ |
| 1889 | 220,140 | 5,466 | 40,291 | 170,965 | 179,849 | ............ |

*a* Not specified since 1883.

# INFUSORIAL EARTH.

# INFUSORIAL EARTH.

BY E. W. PARKER.

## PRODUCTION.

Infusorial earth has been found in useful quantity in a number of places in California, Connecticut, Maryland, Nevada, New Hampshire, New Jersey, New Mexico, Oregon, and Virginia, but the production in 1889 was limited to 5 states, namely, California, Connecticut, Maryland, New Hampshire, and New Jersey. The bulk of the product was obtained from the Dunkirk district, in Maryland, the ledge at Dunkirk producing 3,000 short tons and all other localities 466 short tons. An excellent deposit of infusorial earth was opened at Popes Creek, Maryland, in 1887, and a considerable quantity taken out, but owing to a slack demand only 50 tons were produced at this point in 1889. In Storey county, Nevada, there is a mine of a fine quality of infusorial earth, but no work was done upon it in the census year. The following table shows the production of infusorial earth in 1889, by states:

PRODUCTION OF INFUSORIAL EARTH IN 1889, BY STATES.

| STATES. | Amount. (Short tons.) | Value. |
|---|---|---|
| Total | 3,466 | $23,372 |
| California (*a*) | 50 | 8,000 |
| Connecticut (*b*) | 211 | 422 |
| Maryland (*b*) | 3,050 | 10,700 |
| New Hampshire (*a*) | 80 | 2,750 |
| New Jersey (*a*) | 75 | 1,500 |

*a* Separated and ground. *b* Crude at the mines.

## LABOR AND WAGES.

The mines at Dunkirk, Maryland, were the only ones which were operated actively during the year. The work at the other producing localities was irregular and of short duration. In protection of individual interests the statistics pertaining to labor, wages, and capital for the entire United States are grouped.

LABOR AND WAGES.

| DISTRIBUTION. | Average number employed. | Average wages per day. | Average number of days worked. |
|---|---|---|---|
| Total | 52 | | |
| Foremen | 3 | $2.83 | 93 |
| Mechanics | 4 | 2.50 | 145 |
| Laborers | 45 | 1.30 | 107 |

OPERATING EXPENSES.

| | |
|---|---|
| Wages | $8,388 |
| Paid contractors | 575 |
| Paid for supplies | 760 |
| Paid for other expenditures (rent, insurance, taxes, etc.) | 6,955 |
| Total | 16,678 |

CAPITAL INVESTED.

| | |
|---|---|
| In land | $61,380 |
| In buildings, machinery, etc | 21,900 |
| In tools, implements, live stock, etc | 16,970 |
| In cash | 10,500 |
| Total | 110,750 |

## USES.

Infusorial earth is used to a considerable extent in the manufacture of various cleansing preparations, either in the form of powder or soap. The greater portion of the product of this country is dried in furnaces at the pits and used for making protective coating for boilers. Some infusorial earth has been imported from Germany and used as an absorbent in the manufacture of dynamite from nitroglycerin. The American product, however, does not possess sufficient absorbent properties for this purpose, and the German product has been supplanted by the use of wood pulp, which answers the purpose excellently and is much cheaper. The first development of infusorial earth properties in California was made in 1889. This was due to the discovery of a valuable ledge near Calistoga, Napa county. By practical tests it was learned that the mineral was excellently adapted for use as a polishing powder, and a number of ladies organized a stock company for the purpose of mining and manufacturing the mineral. The property was considerably developed during 1889, and indications pointed to extensive operations in the near future.

The following table shows the analyses of infusorial earths from various localities:

ANALYSES OF INFUSORIAL EARTHS FROM VARIOUS LOCALITIES.

| INGREDIENTS. | From Popes Creek, Maryland. (a) (Per cent.) | From Morris county, New Jersey. (Per cent.) | From near Richmond, Virginia. (b) (Per cent.) | From Storey county, Nevada. (c) (Per cent.) |
|---|---|---|---|---|
| Total | 100.00 | 99.09 | 98.95 | 100.00 |
| Moisture | 3.47 | | 8.37 | |
| Silica | 81.53 | 80.66 | 75.86 | 81.08 |
| Alumina | 3.43 | 3.84 | 9.88 | |
| Protoxide of iron | 3.33 | | | |
| Lime | 2.61 | 0.58 | 0.29 | |
| Ferric oxide | | | 2.92 | |
| Magnesia, soda, potash, sulphur, and organic matter | 5.63 | | 1.63 | |
| Loss on ignition | | 14.01 | | |
| Water at red heat | | | | 18.44 |
| Loss | | | | 0.48 |

[a] Made by Mr. P. de P. Ricketts, of New York. [b] Made by Mr. J. M. Cabell. [c] Made by Mr. W. Habirshaw.

# CORUNDUM.

# CORUNDUM.

BY E. W. PARKER.

## OCCURRENCE.

Corundum and emery are distinguished from each other in that the former is simply the oxide of aluminum found native, while emery is oxide of aluminum mixed with oxide of iron. Emery is not found in any workable quantity in the United States, while corundum is found to a considerable extent in the eastern states. The principal localities are Chester, Massachusetts; Macon and Clay counties, North Carolina, and Rabun county, Georgia. Small quantities have been produced in Westchester county, New York, and Delaware county, Pennsylvania.

## PRODUCTION.

The amount of corundum produced in the United States in 1889 was 2,245 short tons, valued at the mines at $105,565. The entire industry is controlled by 3 or 4 firms, and in order to protect private interests it is deemed best not to publish the figures by states.

## LABOR AND WAGES.

The following table shows the number of men employed at corundum mines in the United States in 1889, the average wages paid each class per day, and the number of days worked:

LABOR EMPLOYED AT CORUNDUM MINES IN 1889.

| DISTRIBUTION. | Average number employed. | Average wages per day. | Average number of days worked. |
|---|---|---|---|
| Total | 129 | | |
| Above ground: | | | |
| Foremen | 5 | $2.63 | 269 |
| Mechanics | 5 | 1.40 | 266 |
| Laborers | 45 | 1.12 | 253 |
| Below ground: | | | |
| Foremen | 2 | 1.87 | 299 |
| Miners | 66 | 1.30 | 292 |
| Laborers | 6 | 1.17 | 217 |

OPERATING EXPENSES IN PRODUCING CORUNDUM.

| | |
|---|---|
| Wages, including office force at mines | $44,660 |
| Paid contractors | 600 |
| Paid for supplies | 9,383 |
| Other expenditures | 2,462 |
| Total | 57,105 |

CAPITAL INVESTED.

| | |
|---|---|
| In land | $21,600 |
| In buildings, machinery, etc | 11,100 |
| In tools, implements, etc | 28,200 |
| Cash | 12,500 |
| Total | 73,400 |

## PRODUCTION IN PREVIOUS YEARS.

A considerable increase is noted in the production of corundum by comparing the figures for 1889 with those for 1880. The following table is given for comparison:

COMPARATIVE STATISTICS OF CORUNDUM PRODUCTION FOR 1889 AND 1880.

| YEARS. | Quantity. (Short tons.) | Value. |
|---|---|---|
| 1889 | 2, 245 | $105, 565 |
| 1880 | 1, 044 | 29, 280 |
| Increase | 1, 201 | 76, 285 |

The estimates of the production for the intermediate years, as published in the Mineral Resources of the United States, cover only the product of the mines in North Carolina and Georgia, and the values are given for the mineral in a more advanced stage of preparation for market; hence they are of little value for comparative statistics, as shown in the following table:

ESTIMATED PRODUCTION OF CORUNDUM FOR THE YEARS 1881 TO 1888, INCLUSIVE.

| YEARS. | Quantity. (Short tons.) | Value. |
|---|---|---|
| 1881 | 500 | $80, 000 |
| 1882 | 500 | 80, 000 |
| 1883 | 550 | 100, 000 |
| 1884 | 600 | 108, 000 |
| 1885 | 600 | 108, 000 |
| 1886 | 645 | 116, 190 |
| 1887 | 600 | 108, 000 |
| 1888 | 589 | 91, 620 |

## IMPORTS.

All corundum consumed in the United States is of domestic production. The emery used is imported, coming principally from Asia Minor.

The following table shows the imports of emery from 1867 to 1889, inclusive:

EMERY IMPORTED INTO THE UNITED STATES FROM 1867 TO 1889, INCLUSIVE.

| YEARS ENDED— | Total value. | GRAINS. | | ORE OR ROCK. | | PULVERIZED OR GROUND. | | Other manufactures. |
|---|---|---|---|---|---|---|---|---|
| | | Quantity. (Pounds.) | Value. | Quantity. (Tons.) | Value. | Quantity. (Pounds.) | Value. | |
| June 30, 1867 | $52, 504 | | | 428 | $14, 373 | 924, 431 | $38, 131 | |
| 1868 | 38, 080 | | | 85 | 4, 531 | 834, 286 | 33, 549 | |
| 1869 | 77, 916 | | | 964 | 35, 205 | 924, 161 | 42, 711 | |
| 1870 | 54, 866 | | | 742 | 25, 335 | 644, 080 | 29, 531 | |
| 1871 | 44, 811 | | | 615 | 15, 870 | 613, 624 | 28, 941 | |
| 1872 | 77, 424 | | | 1, 641 | 41. 321 | 804, 977 | 36, 103 | |
| 1873 | 70, 919 | 610, 117 | $29, 706 | 755 | 26, 065 | 343, 828 | 15, 041 | $107 |
| 1874 | 62, 366 | 331, 580 | 16, 216 | 1, 281 | 43, 886 | 69. 890 | 2, 167 | 97 |
| 1875 | 58, 327 | 487, 725 | 23, 345 | 961 | 31, 972 | 85, 853 | 2, 990 | 20 |
| 1876 | 61, 653 | 385, 246 | 18, 999 | 1, 395 | 40, 027 | 77, 382 | 2, 533 | 94 |
| 1877 | 42, 182 | 343, 697 | 16, 615 | 852 | 21, 964 | 96, 351 | 3, 603 | |
| 1878 | 56, 601 | 334, 291 | 16, 359 | 1, 475 | 38, 454 | 65, 068 | 1, 754 | 34 |
| 1879 | 87, 506 | 496, 633 | 24, 456 | 2, 478 | 58, 065 | 133, 556 | 4, 985 | |
| 1880 | 105, 894 | 411, 340 | 20, 066 | 3, 400 | 76, 481 | 223, 855 | 9, 202 | 145 |
| 1881 | 97, 432 | 454, 790 | 22, 101 | 2, 884 | 67, 781 | 177, 174 | 7, 497 | 53 |
| 1882 | 98, 695 | 520, 214 | 25, 314 | 2, 765 | 69, 432 | 117, 008 | 3, 708 | 241 |
| 1883 | 85, 490 | 474, 105 | 22, 767 | 2. 447 | 59, 282 | 93, 010 | 3, 172 | 269 |
| 1884 | 148, 890 | 143, 267 | 5, 802 | 4, 145 | 121, 719 | 513, 161 | 21, 181 | 188 |
| 1885 | 74, 800 | 228, 329 | 9, 886 | 2, 445 | 55, 368 | 194, 314 | 8, 789 | 757 |
| Dec. 31, 1886 | 121, 638 | 161, 297 | 6, 910 | 3, 782 | 88, 925 | 365, 947 | 24, 952 | 851 |
| 1887 | 68, 209 | 367, 239 | 14, 290 | 2, 078 | 45, 033 | *a*144, 380 | 6, 796 | 2, 090 |
| 1888 | 118, 246 | 430, 397 | 16, 216 | 5, 175 | 93, 287 | | | 8, 743 |
| 1889 | 218, 966 | 503, 347 | 18, 937 | 5, 234 | 88, 727 | | | 111, 302 |

*a* To June 30 only; since classed with grains.

# MILLSTONES.

# MILLSTONES.

BY E. W. PARKER.

## PRODUCTION.

The total value of millstones produced in 1889 was $35,155. The estimated value of the entire product for 1888 was $81,000, showing a decrease of about 57 per cent. While it is true that the demand for domestic millstones is steadily decreasing, it must be taken into consideration that the values of the product for 1888 and previous years were estimated and probably considerably exaggerated, owing to the prevalent desire of operators to make a favorable showing for their particular localities, and possibly, also, to a duplication of returns. It must also be remembered that the census report covers only those engaged in the quarrying and cutting of domestic stone. Manufacturers of millstones from French buhr or dealers in imported buhrstones are not included in this report, except by such reference as may be made to imports.

## LOCALITIES.

The flint and quartz conglomerate from which millstones are made is found at different places along the Allegheny mountains. In Ulster county, New York, it is quarried under the name of "Esopus stone"; in Lancaster county, Pennsylvania, it is known as "Cocalico stone"; in Montgomery county, Virginia, it is called "Brush Mountain stone", and in Moore county, North Carolina, it is termed "North Carolina grit".

The following table shows the estimated values of the product of the different regions from 1883 to 1888, inclusive, and the value of the product for 1889:

VALUE OF MILLSTONES PRODUCED IN THE UNITED STATES FROM 1883 TO 1889, INCLUSIVE.

| KINDS. | 1883. | 1884. | 1885. | 1886. | 1887. | 1888. | 1889. |
|---|---|---|---|---|---|---|---|
| Total | $150,000 | $150,000 | $100,000 | $140,000 | $100,000 | $81,000 | $35,155 |
| Esopus stone | 120,000 | 110,000 | 90,000 | 100,000 | 75,000 | 60,000 | 23,377 |
| Cocalico stone | 30,000 | 40,000 | 10,000 | 10,000 | 5,000 | 1,000 | 5,800 |
| Brush Mountain stone (a) | | | | | | | 5,978 |
| North Carolina grit (b) | | | | 30,000 | 20,000 | 20,000 | |

a No figures have been published previous to 1889.

b No figures have been published previous to 1886, and the quarries were abandoned in 1889. A few stones were made in the latter year from material previously quarried, but no work was done at the quarries.

## LABOR AND WAGES.

The quarrying and cutting of millstones is a very irregular industry, those engaged in it operating only upon orders. As a rule, no record of any kind is kept, and each cutter is as much as possible an independent operator. He receives an order for a stone, repairs to the mountain, finds a slab from which the desired size may be readily obtained, and then employs what help he needs to cut the stone and haul it to the nearest railroad station. The figures given in the following table cover the industry for the United States, and are partly estimates, based upon statements of the larger operators, the men making about half time during the year:

EMPLOYÉS.

| CLASSIFICATION. | Average number employed. | Average wages per day. |
|---|---|---|
| Total | 98 | |
| Foremen | 3 | $3.00 |
| Cutters | 42 | 2.00 |
| Laborers | 51 | 1.16 |
| Boys under 16 years of age | 2 | 1.00 |

## EXPENDITURES.

The following statement shows the total amount of wages paid during 1889, the amount paid contractors, the value of supplies consumed, and other expenses connected with the quarrying and cutting of millstones:

### OPERATING EXPENSES IN PRODUCING MILLSTONES.

| | |
|---|---|
| Paid for wages | $17, 853 |
| Paid contractors | 1, 193 |
| Paid for supplies | 1, 413 |
| Paid for royalty | 540 |
| Other expenditures (including rent, taxes, insurance, interest, etc.) | 385 |
| Total | 21, 384 |

## CAPITAL.

In compiling the returns relative to capital it is necessary to estimate a large portion of the amount invested in land. This estimate is based on the royalty paid by operators for the stone taken out. The royalty is usually paid at a fixed rate per pair.

### CAPITAL EMPLOYED.

| | |
|---|---|
| In land | $29, 270 |
| In buildings, machinery, etc | 3, 300 |
| In tools, implements, live stock, etc | 16, 375 |
| In cash (not reported in foregoing items) | 6, 000 |
| Total | 54, 945 |

The decrease in the demand for millstones is due in most part to the introduction of the roller process for grinding cereals. Grinders of paints, cement rock, gypsum, etc., continue to use domestic stones, and for these purposes the form known as "chasers" is usually employed. Proprietors of flouring mills who have not adopted the roller process prefer stones made from French buhr, a quality of stone which has not yet been found in the United States.

### VALUE OF BUHRSTONES AND MILLSTONES IMPORTED INTO THE UNITED STATES FROM 1868 TO 1889.

| YEARS ENDED— | Total. | Rough. | Made into millstones. |
|---|---|---|---|
| June 30, 1868 | $74, 224 | $74, 224 | ........... |
| 1869 | 60, 361 | 57, 942 | $2, 419 |
| 1870 | 60, 898 | 58, 601 | 2, 297 |
| 1871 | 39, 104 | 35, 406 | 3, 698 |
| 1872 | 75, 029 | 69, 062 | 5, 967 |
| 1873 | 68, 578 | 60, 463 | 8, 115 |
| 1874 | 79, 710 | 36, 540 | 43, 170 |
| 1875 | 115, 059 | 48, 068 | 66, 991 |
| 1876 | 84, 087 | 37, 759 | 46, 328 |
| 1877 | 83, 925 | 60, 857 | 23, 068 |
| 1878 | 89, 607 | 87, 679 | 1, 928 |
| 1879 | 106, 572 | 101, 484 | 5, 088 |
| 1880 | 125, 072 | 120, 441 | 4, 631 |
| 1881 | 103, 912 | 100, 417 | 3, 495 |
| 1882 | 104, 034 | 103, 287 | 747 |
| 1883 | 73, 685 | 73, 413 | 272 |
| 1884 | 46, 100 | 45, 837 | 263 |
| 1885 | 35, 477 | 35, 022 | 455 |
| Dec. 31, 1886 | 29, 935 | 29, 273 | 662 |
| 1887 | 24, 007 | 23, 816 | 191 |
| 1888 | 37, 228 | 36, 523 | 705 |
| 1889 | 40, 884 | 40, 432 | 452 |

# WHETSTONES.

# WHETSTONES.

BY E. W. PARKER.

## VARIETIES AND OCCURRENCE.

The sources of supply of siliceous rock in the United States used for sharpening edged tools have been the same for some years. Arkansas, Indiana, and New Hampshire furnish the bulk of the supply, and a small quantity is produced in Vermont. The Arkansas stone is found in the neighborhood of Hot Springs, and is supposed to have been formed by the action of hot water upon the quartz formations. It is found in 2 varieties, known as Arkansas and Washita stone, the grains in the former being smaller and more compact, of a uniform bluish-white color, and semitransparent, while the Washita stone is more opaque and of a pure white color. In Indiana 2 varieties also occur, known commercially as Hindostan and Orange stone, the former being white in color and the latter of a buff or orange tint. The quarries are all located in Orange county. The quarries in New Hampshire are located in Grafton county, and the product consists of rift sandstone and chocolate whetstone. The Vermont quarries are located in Orleans county, and the product is used exclusively for scythestones. Some Labrador oilstones have in the past been produced at Manlius, Onondaga county, New York, but the factory is now used for the manufacture of oilstones from Arkansas and Washita stone.

## PRODUCTION.

The product of the different kinds of sharpening stones in 1889 consisted of 456 tons of scythestone, 1,500 tons of rift sandstone, 30,000 pounds of orange stone, 1,036,000 pounds of Washita oilstone, 175,000 pounds of Arkansas oilstone, and 200,179 pounds of Hindostan oilstone. The production, by states, is shown in the following table, and for the sake of convenience the quantity is expressed in short tons, the weight and value given being for rough stone:

PRODUCTION OF SHARPENING STONES IN THE UNITED STATES FOR 1889, BY STATES.

[Short tons.]

| STATES. | Quantity. | Value. |
|---|---|---|
| Total | 2,991 | $32,980 |
| Arkansas | 814 | 20,360 |
| Indiana | 212 | 7,670 |
| New Hampshire | 1,515 | 3,750 |
| Vermont | 450 | 1,200 |

LABOR EMPLOYED IN PRODUCING WHETSTONES.

| STATES. | AVERAGE NUMBER EMPLOYED. | | | | AVERAGE WAGES PAID. | | | | AVERAGE NUMBER OF DAYS WORKED. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Foremen. | Mechanics. | Laborers. | Boys under 16 years. | Foremen. | Mechanics. | Laborers. | Boys under 16 years. | Foremen. | Mechanics. | Laborers. | Boys under 16 years. |
| Total | 13 | 1 | 68 | 9 | $2.08 | $1.50 | $1.27 | $0.72 | 187 | 130 | 189 | 182 |
| Arkansas | 6 | | 32 | | 2.33 | | 1.50 | | 178 | | 177 | |
| Indiana | 4 | | a22 | 8 | 1.25 | | 0.86 | 0.75 | 225 | | 249 | 200 |
| New Hampshire | 2 | 1 | 9 | 1 | 3.00 | 1.50 | 1.47 | 0.50 | 179 | 130 | 134 | 35 |
| Vermont | 1 | | 5 | | 2.00 | | 1.25 | | 100 | | 100 | |

a Includes 2 miners and 1 laborer underground.

### OPERATING EXPENSES IN PRODUCING WHETSTONES.

| STATES. | Total expenditures. | Wages. | Paid contractors. | Paid for supplies. | Other expenditures. |
|---|---|---|---|---|---|
| Total | $23,804 | $21,911 | $800 | $838 | $255 |
| Arkansas | 11,875 | 11,060 | 800 | | 15 |
| Indiana | 7,148 | 6,763 | | 235 | 150 |
| New Hampshire and Vermont (*a*) | 4,781 | 4,088 | | 603 | 90 |

*a* These 2 states are combined in order that the business of individual establishments may not be disclosed to the public.

### CAPITAL INVESTED.

| STATES. | Total. | In land. | In buildings, machinery, etc. | In tools, implements, live stock, etc. | In cash. |
|---|---|---|---|---|---|
| Total | $57,510 | $42,500 | $3,925 | $6,885 | $4,200 |
| Arkansas | 20,825 | 18,000 | 625 | 700 | 1,500 |
| Indiana | 9,225 | 4,700 | 700 | 1,825 | 2,000 |
| New Hampshire and Vermont (*a*) | 27,460 | 19,800 | 2,600 | 4,360 | 700 |

*a* These 2 states are combined in order that the business of individual establishments may not be disclosed to the public.

## EXPORTS AND IMPORTS.

Considerable quantities of whetstone and scythestone are exported from the United States, but the material is classed with marble, limestone, etc., and there is no way of ascertaining the quantities or values of each. The imports consist of manufactured whetstones and razor hones, and are shown in the following table:

### IMPORTS OF WHETSTONES AND RAZOR HONES FOR THE YEARS 1880 TO 1889, INCLUSIVE.

| Years ended— | |
|---|---|
| June 30, 1880 | $14,185 |
| 1881 | 16,631 |
| 1882 | 27,882 |
| 1883 | 30,178 |
| 1884 | 26,513 |
| 1885 | 21,434 |
| Dec. 31, 1886 | 21,141 |
| 1887 | 24,093 |
| 1888 | 30,676 |
| 1889 | 27,400 |

# MICA.

# MICA

BY L. J. CHILDS.

## GENERAL REVIEW OF THE INDUSTRY.

The production of cut mica in the United States in the census year amounted to 49,500 pounds, valued at $50,000. In addition to this, 196 short tons of scrap or waste mica were sold for grinding purposes, with a value of $2,450. The production in 1880, as given in the Tenth Census report, was 81,669 pounds of cut mica, valued at $127,825.

A review of the annual production during the past 9 years shows that the industry advanced in importance until 1885. Since then the tendency has been downward, though the fluctuations in the production of the different regions have caused much irregularity in the annual totals. The following table does not include statistics of scrap and waste mica, as there had been no attempt prior to 1889 to determine the amount of this waste which has been utilized:

CUT MICA PRODUCED IN THE UNITED STATES.

| YEARS. | Amount. (Pounds.) | Value. |
|---|---|---|
| 1880 | 81,669 | $127,825 |
| 1881 | 100,000 | 250,000 |
| 1882 | 100,000 | 250,000 |
| 1883 | 114,000 | 285,000 |
| 1884 | 147,410 | 368,525 |
| 1885 | 92,000 | 161,000 |
| 1886 | 40,000 | 70,000 |
| 1887 | 70,000 | 142,250 |
| 1888 | 48,000 | 70,000 |
| 1889 | 49,500 | 50,000 |

During the years 1883 and 1884, when mica mining was in its most flourishing condition, the manufacturers of stoves consumed probably 95 per cent of the product, and the fancy grades and large sizes of sheet mica which were then used found a ready sale at highly profitable prices. Under this stimulus of large profits many surface deposits or pockets were opened by farmers or other individuals of small means, who worked them occasionally when other business was dull and realized a considerable profit on their production. As long as the demand for large sizes continued this intermittent sort of mining could be carried on with a degree of success, but when the fashion in stove panels changed and small sheets were used in place of the large ones, the demand for the latter fell off to a great extent. Mica suitable for cutting into large sheets was much less abundant than that available for small sizes; therefore lower rates had always prevailed for the latter, and careful, steady, and systematic methods were necessary to produce such grades profitably. When the demand changed from large to small sizes the majority of miners were unprepared, through lack of capital or for other reasons, to adopt such methods. The result was a great reduction in the number of producing mines, and consumers were compelled either to raise the price of mica or look to foreign sources for their supply. Another factor in increasing importation came into existence with the extended manufacture of dynamos and other electrical apparatus, in which a great deal of mica is used. The foreign article, especially that produced in Canada, was, on account of its superior cleavage, preferred to the domestic for this purpose, but since miners have become more fully acquainted with the qualities desired for electrical uses it has been proved that the United States can produce mica for this purpose equal to any found abroad. The foreign supply, after gaining a foothold in American markets, has more than held its own, and as its tendency has always been toward a reduction in prices there has been little inducement for the outlay of capital in mica mining.

Only a small number of mines were operated in 1889, and few of these were worked steadily throughout the year. However, there was a fair amount of development work done in the different mica regions, and it is expected that the introduction of more systematic methods of mining will greatly increase the importance of the industry.

## OCCURRENCE.

Mica is one of the natural constituents of a number of the more common rocks, and as such it is widely distributed throughout the United States, but the localities in which it occurs in an available form are not very numerous. While deposits have been noted in nearly all of the states on the eastern border of the Appalachian mountain system, it is only in New Hampshire and North Carolina that the industry has assumed at any time much importance. In the west the most important deposits are located in the Black Hills, in the neighborhood of Harteville, Wyoming, and in the Cribbensville district of New Mexico.

The available deposits of mica occur in bands of coarsely crystalline granite. In these bands the 3 constituents of the granite (mica, feldspar, and quartz) have in a measure crystallized in separate masses, and the mica is found in bunches or pockets irregularly distributed throughout the mass. The deposits are of great interest aside from their commercial importance on account of the number of rare minerals which are nearly always present. Among these are beryl, tourmaline, garnet, columbite, and samarskite. In some cases one or more of these minerals are present in sufficient quantity and of such fine quality as to give value to the deposit. Some of the finest tourmalines in the world have been found at Mount Mica, near the town of Paris, Maine, in the mica deposit at that place. Tin ore is also an accompaniment of the mica deposits in the Black Hills region.

## TREATMENT OF THE CRUDE PRODUCT.

Mica is used in two forms, sheet mica and ground mica, and the manner in which it is treated when taken from the mine depends upon the form in which it is to be used. If it is to be sold as scrap for grinding, all that is necessary is to remove the adhering fragments of quartz and feldspar and such parts of the mica as may contain foreign ingredients. If it is to be used in sheet form, the process is much more complicated, the blocks being first split into sheets thin enough to cut easily, then marked with a pattern of the size desired, cut along the lines marked, and the different sizes wrapped in paper and packed for shipment. There is a great amount of waste about this operation. The amount of sheet mica obtained does not usually exceed from 4 to 8 per cent of the block mica treated.

## USES.

The most common and well-known use for mica is in the paneling of stove and furnace doors. For this purpose the mica must be clear, free from spots, and of a uniform color throughout the sheet. The most desirable color is a wine red, and next to this comes white mica, which is nearly as valuable. Another important use is in the manufacture of electrical apparatuses, for which purpose its nonconducting properties render it valuable. The qualities required for this use are firmness of texture, toughness, and ready cleavage.

There is a greater range of use for ground mica than for the mineral in sheets, and though the value of that part of the product made use of in this form is small, the many peculiar properties which ground mica possesses render it quite probable that its use will be widely extended. The difficulties to be overcome in grinding mica are considerable, and there are only 2 or 3 firms engaged in the business at present. 8 standard grades of ground mica are made. The coarsest of these are used to give frosted and spangled effects to the fancy grades of wall paper. The medium grades are employed in the manufacture of a lubricant for the journals of railway carriages, for heavy bearings generally, and for the axles of road vehicles. The finest grades are used in producing a uniform metallic white surface on wall paper. Scrap mica for grinding must be white and as free from specks or colored matter as possible, since any impurities in the scrap will affect the color and luster of the product.

## PRODUCTION.

Much trouble has been experienced in collecting statistics of production and other data owing to the general lack of systematic records among the miners, and the figures furnished by them for the Census Office were for the most part estimates. The greater part of the product in 1889 was taken from 1 mine in New Hampshire. Of the North Carolina mines none were in steady operation throughout the year, and the production of that state was the result of irregular and spasmodic efforts. In Virginia the production was confined to 1 mine, located at Amelia Court House, which was exhausted early in the year. In the Black Hills region, where, in 1884, 11 mines were operated, with a production of over 18,000 pounds of mica, only 1 produced in 1889, and that only a small amount. In New Mexico a good deal of developing work was done and a quantity of good mica was reported as taken out; but as none of this was marketed, it has not been included in the totals for 1889. In the following table the production of Virginia and South Dakota is included under one head, that the operations of private individuals may not be disclosed.

### PRODUCTION AND VALUE OF MICA IN THE UNITED STATES IN 1889, BY STATES.

| STATES. | CUT. | | SCRAP. | |
|---|---|---|---|---|
| | Pounds. | Value. | Short tons. | Value. |
| Total | 49, 500 | $50, 000 | 196 | $2, 450 |
| New Hampshire | 40, 000 | 40, 000 | 160 | 2, 000 |
| North Carolina | 6, 700 | 7, 000 | ........... | ........... |
| Virginia and South Dakota | 2, 800 | 3, 000 | 36 | 450 |

## EXPENDITURES.

The laws relating to mining claims in the western states require that work to the extent of not less than $100 per year shall be expended on each claim. The amount involved in this assessment work, together with that expended in the development of mines at which no mica was produced in 1889, amounted to $12,910, and this sum has been included in the following table of expenditures.

### EXPENDITURES AT MICA MINES IN THE UNITED STATES IN 1889, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | Total. | Wages. | Supplies. | Other expenses. |
|---|---|---|---|---|
| Total | $58, 335 | $42, 174 | $7, 408 | $8, 753 |
| New Hampshire | 38, 635 | 28, 330 | 5, 305 | 5, 000 |
| North Carolina | 12, 722 | 7, 266 | 1, 703 | 3, 753 |
| New Mexico | 2, 250 | 2, 050 | 200 | ........... |
| Other states (*a*) | 4, 728 | 4, 528 | 200 | ........... |

*a* Including Virginia, Massachusetts, South Dakota, Wyoming, and Idaho.

## LABOR AND WAGES.

The men employed at mica mines in 1889 numbered 185 and drew wages to the amount of $42,174, but of this number only a small proportion were steadily employed throughout the year. The scale of wages in force in the mines in different sections of the country shows a wide range in the amounts paid for the same class of work in different localities. The following table gives the number of men of each class employed in each state, with the average wages per day and the average number of days worked:

### MEN EMPLOYED AND WAGES PAID AT MICA MINES IN THE UNITED STATES IN 1889, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | FOREMEN. | | | MECHANICS. | | | MINERS. | | | LABORERS. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number employed. | Average wages per day. | Average number of days worked. | Number employed. | Average wages per day. | Average number of days worked. | Number employed. | Average wages per day. | Average number of days worked. | Number employed. | Average wages per day. | Average number of days worked. |
| New Hampshire | *a*6 | $2. 75 | 300 | 7 | $1. 50 | 300 | 24 | $1. 50 | 250 | 33 | $1. 50 | 250 |
| North Carolina | 4 | 1. 10 | 110 | ........... | ........... | ........... | 34 | 0. 75 | 110 | 25 | 0. 75 | 75 |
| Virginia | 3 | 1. 75 | 100 | ........... | ........... | ........... | 16 | 0. 75 | 100 | 7 | 1. 10 | 80 |
| South Dakota | 1 | 3. 00 | 60 | ........... | ........... | ........... | ........... | ........... | ........... | 2 | 3. 00 | 60 |
| New Mexico | 1 | 2. 00 | 100 | ........... | ........... | ........... | 10 | 2. 00 | 75 | 1 | 1. 00 | 15 |
| Massachusetts | ........... | ........... | ........... | ........... | ........... | ........... | 4 | 1. 50 | 180 | ........... | ........... | ........... |
| Wyoming | ........... | ........... | ........... | ........... | ........... | ........... | 4 | 2. 50 | 50 | ........... | ........... | ........... |
| Idaho | ........... | ........... | ........... | ........... | ........... | ........... | 3 | 2. 00 | 17 | ........... | ........... | ........... |

*a* Including office force.

## CAPITAL INVESTED.

The total amount invested in the mica-mining industry in the United States in 1889 is given at $691,550. The North Carolina region contains a majority of the mines of the country, but most of these are small and little improved in the way of buildings and machinery. Those of New Hampshire are much better fitted in this respect for steady and systematic mining, and this fact accounts, in part at least, for the larger production of that state. The following table gives the capital invested by states:

### CAPITAL INVESTED IN MICA MINES IN THE UNITED STATES IN 1889, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | Total. | Land. | Buildings, etc. | Tools, etc. | Cash. |
|---|---|---|---|---|---|
| Total | $691, 550 | $636, 560 | $28, 340 | $21, 250 | $5, 400 |
| North Carolina | 438, 475 | 420, 710 | 6, 090 | 8, 675 | 3, 000 |
| New Hampshire | 194, 750 | 160, 350 | 20, 350 | 11, 650 | 2, 400 |
| Georgia | 21, 500 | 21, 250 | 200 | 50 | ............ |
| New Mexico | 14, 700 | 13, 400 | 950 | 350 | ............ |
| South Dakota | 13, 300 | 13, 000 | 200 | 100 | ............ |
| South Carolina | 4, 600 | 4, 600 | ............ | ............ | ............ |
| New York | 2, 000 | 1, 300 | 500 | 200 | ............ |
| Idaho | 1, 000 | 925 | 50 | 25 | ............ |
| Other states (*a*) | 1, 225 | 1, 025 | ............ | 200 | ............ |

*a* Including Massachusetts, Pennsylvania, and Wyoming.

### UNMANUFACTURED MICA IMPORTED INTO THE UNITED STATES.

| Years ended— | |
|---|---|
| June 30, 1869 | $1, 165 |
| 1870 | 226 |
| 1871 | 1, 460 |
| 1872 | 1, 002 |
| 1873 | 498 |
| 1874 | 1, 204 |
| 1875 | ...... |
| 1876 | 569 |
| 1877 | 13, 085 |
| 1878 | 7, 930 |
| 1879 | 9, 274 |

| Years ended— | |
|---|---|
| June 30, 1880 | $12, 562 |
| 1881 | 5, 839 |
| 1882 | 5, 175 |
| 1883 | 9, 884 |
| 1884 | 28, 284 |
| 1885 | 28, 685 |
| Dec. 31, 1886 | 56, 354 |
| 1887 | 49, 085 |
| 1888 | 57, 541 |
| 1889 | 97, 351 |

# ASBESTOS.

# ASBESTOS.

BY E. W. PARKER.

## VARIETIES.

The fibrous material known to the trade under the name of asbestos comprises at least two distinct species of minerals, one of which, a variety of hornblende, is properly called asbestos; the other is chrysotile, a variety of serpentine, and may be readily distinguished from asbestos by yielding water when heated in a closed tube. Both asbestos and chrysotile are found in regions of altered crystalline rocks, and yet each has its own particular associates. The former occurs with metamorphic rocks rich in hornblende, while the latter is found in distinct veins penetrating masses of serpentine, which have resulted generally from the alteration of eruptive rocks rich in olivine. It is customary, however, in trade circles to include both varieties under the name of asbestos, and they are so treated in this report.

Asbestos is found in the United States in a comparatively narrow belt of metamorphic rocks, extending along the Piedmont region or eastern slope of the Appalachian mountains, from New York, through Pennsylvania, Maryland, Virginia, North Carolina, and South Carolina, into Georgia. It is inferior in quality to the best that is mined in Italy or Canada. Its fibers are comparatively short and somewhat spindle-shaped, with occasional cross fractures, which not only render it brittle but diminish its tensile strength. Asbestos is also found in considerable quantities in California and Wyoming, but this also lacks the essential quality of strength of fiber.

The asbestos of Canada properly belongs to the chrysotile variety. It is found in the Thetford region, and is now being extensively mined. It occurs in serpentine in irregular veins varying in thickness from a mere film to 6 inches. The fibers extend directly across the vein, are long and even as well as flexible, slightly elastic, and of great tensile strength.

## PRODUCTION.

The production of asbestos in the United States has shown an annual decrease since 1882. The product for 1882 was 1,200 short tons; 1883, 1,000 short tons, and 1884, 1,000 short tons. The product for 1885 showed a decided drop, being only 300 short tons, and this was again reduced to 200 short tons in 1886 and 150 short tons in 1887. In 1888 the product was 100 short tons, valued at $30 per ton. In 1889 the only asbestos mined in this country and marketed came from California, amounting to 30 tons, valued at $1,800. A trifling amount of asbestos, about 300 pounds, was taken out and saved as a by-product in quarrying soapstone in Pennsylvania and sold locally to druggists and chemists at an average price of 9 cents per pound. This small factor has been omitted from the total.

There was a considerable amount of development work done on asbestos mines in Wyoming, but the product was not placed upon the market. These mines are situated about 22 miles from Rock Creek, on the Union Pacific railroad. The veins and pockets are said to be numerous, extending in all directions, and vary in width from a few inches to over 4 feet. Some of the fibers are reported to be over 40 inches in length, but that so far obtained is somewhat brittle, though improving in quality as greater depth is reached.

## EXPENDITURES.

In the statement following, showing the amount of money paid for wages, etc., there is included the sum of $1,900, which was expended in development work at mines in Wyoming. The statement of capital also includes that invested in Wyoming properties.

OPERATING EXPENSES IN PRODUCING ASBESTOS.

| | |
|---|---|
| Wages | $2,700 |
| Supplies consumed | 525 |
| Total | 3,225 |

CAPITAL INVESTED.

| | |
|---|---|
| In land | $41,500 |
| In buildings, machinery, etc | 600 |
| In tools, implements, live stock, etc | 500 |
| Total | 42,600 |

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NOTE.—Acknowledgments are due Professor J. S. Diller, of the United States geological survey, for valuable information regarding the varieties and occurrence of asbestos.

## LABOR AND WAGES.

The following table shows the number of men employed, the average wages paid per day, and the average number of days worked by each class:

EMPLOYÉS AT ASBESTOS MINES IN THE UNITED STATES IN 1889.

| DISTRIBUTION. | Average number employed. | Average wages per day. | Average number of days worked. |
|---|---|---|---|
| Total | 12 | | |
| Above ground: | | | |
| Foremen | 1 | $2.75 | 75 |
| Laborers | 7 | 2.00 | 75 |
| Office force at mines | 1 | | |
| Below ground: | | | |
| Foremen | 1 | 5.00 | 150 |
| Miners | 2 | 2.50 | 150 |

## USES.

Asbestos is used in the manufacture of fireproof paints, roofing, piston packing, felt packing, fireproof cements, sheet and roll millboards, flooring, and for a covering for steam pipes and boilers. It is largely used in lining for fireproof safes, and is also made into yarn, cloth, and paper. Nonconsuming lampwicks and fireproof drop curtains for theaters are now being made of this material. Some demand has also been created for its use in the manufacture of insulators for electric wires. The fiber of the American asbestos is more brittle and harsh than the imported, and not so well adapted to the manufacture of spun and woven goods. It is said, however, to stand a greater degree of heat than the Canadian or foreign material, and is more suitable for the manufacture of fireproof cement and paint, for which the length of fiber is not essential. If the conditions were such that the mineral could be economically mined in this country, it is probable that a considerable amount of capital would be invested in the industry.

## IMPORTS.

The following table shows the value of asbestos imported and entered for consumption in the United States for the years 1869 to 1889, inclusive:

ASBESTOS IMPORTED FROM 1869 TO 1889.

| YEARS ENDED— | Total. | Unmanufactured. | Manufactured. |
|---|---|---|---|
| June 30, 1869 | $310 | | $310 |
| 1870 | 7 | | 7 |
| 1871 | 12 | | 12 |
| 1872 | | | |
| 1873 | 18 | $18 | |
| 1874 | 152 | 152 | |
| 1875 | 5,783 | 4,706 | 1,077 |
| 1876 | 5,881 | 5,485 | 396 |
| 1877 | 3,221 | 1,671 | 1,550 |
| 1878 | 3,908 | 3,536 | 372 |
| 1879 | 7,828 | 3,204 | 4,624 |
| 1880 | 9,736 | 9,736 | |
| 1881 | 27,786 | 27.717 | 69 |
| 1882 | 15,739 | 15,235 | 504 |
| 1883 | 24,612 | 24,369 | 243 |
| 1884 | 49,940 | 48,755 | 1,185 |
| Dec. 31, 1885 | 73,643 | 73,026 | 617 |
| 1886 | 135,125 | 134,193 | 932 |
| 1887 | 140,845 | 140,264 | 581 |
| 1888 | 176,710 | 168,584 | 8,126 |
| 1889 | 263,393 | 254,239 | 9,154 |

The imports of crude asbestos for 1889 were greatly in excess of those for any previous years, being about 51 per cent over those for 1888, 81 per cent over 1887, and 89 per cent over 1886, and exceeding the entire imports from 1869 to 1885, inclusive.

# GRAPHITE.

# GRAPHITE.

BY E. W. PARKER.

## PRODUCTION.

The production of graphite in the United States in 1889 amounted to 7,003 short tons of crude ore. This is partly estimated, as in several instances operators kept no record of the product from the mines, and could only make returns for the quantity of refined graphite obtained, with the value. In such instances the amount of crude product is estimated according to the average per cent of yield of refined graphite per ton of ore. A considerable portion of the graphite produced in 1889 was used in the crude state. The amount of refined graphite obtained has averaged about 400,000 pounds each year during the past decade. It will be observed that in Pennsylvania and Michigan the expenditures are in excess of the value of the product. This fact is due to the large expense incurred in developing some of the graphite properties. These mines show promise of paying activity in the near future.

### PRODUCTION OF CRUDE GRAPHITE IN 1889, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | Crude ore. (Short tons.) | Value. | Total expenses. | Total wages paid. | Paid contractors. | Paid for supplies. | Other expenditures. |
|---|---|---|---|---|---|---|---|
| Total | 7,003 | $72,662 | $54,741 | $38,329 | $2,285 | $7 734 | $6,393 |
| Rhode Island | 500 | 10,000 | 7,800 | 3,800 | ........ | 2,500 | 1,500 |
| New York | 3,460 | 42,410 | 18,370 | 18,370 | ........ | ........ | ........ |
| Pennsylvania | 2,721 | 16,752 | 16,979 | 12,605 | ........ | 3,754 | 620 |
| Michigan and Wyoming (*a*) | 322 | 3,500 | 11,592 | 3,554 | 2,285 | 1,480 | 4,273 |

*a* Michigan and Wyoming are here grouped in order that the business of individual establishments may not be disclosed to the public.

### LABOR EMPLOYED.

| STATES AND TERRITORIES. | ABOVE GROUND. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | Average wages per day. | | | Average number of days worked. | | |
| | Foremen. | Mechanics. | Laborers. | Foremen. | Mechanics. | Laborers. | Foremen. | Mechanics. | Laborers. |
| Total | 3 | 13 | 60 | $2.97 | $1.93 | $1.30 | 236 | 235 | 233 |
| Rhode Island | ........ | 4 | ........ | ........ | 2.00 | ........ | ........ | 300 | ........ |
| New York | ........ | 1 | 30 | ........ | 2.50 | 1.40 | ........ | 300 | 300 |
| Pennsylvania | 2 | 7 | 24 | 1.96 | 1.79 | 1.13 | 247 | 191 | 163 |
| Michigan and Wyoming | 1 | 1 | 6 | 5.00 | 2.00 | 1.50 | 213 | 213 | 182 |

| STATES AND TERRITORIES. | BELOW GROUND. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | Average wages per day. | | | Average number of days worked. | | |
| | Foremen. | Miners. | Laborers. | Foremen. | Miners. | Laborers. | Foremen. | Miners. | Laborers. |
| Total | 3 | 14 | 8 | $3.00 | $1.82 | $1.30 | 170 | 203 | 286 |
| Rhode Island | ........ | 2 | ........ | ........ | 2.25 | ........ | ........ | 300 | ........ |
| New York | ........ | ........ | 6 | ........ | ........ | 1.40 | ........ | ........ | 300 |
| Pennsylvania | 2 | 9 | 2 | 2.00 | 1.50 | 1.00 | 250 | 246 | 245 |
| Michigan and Wyoming | 1 | 3 | ........ | 5.00 | 2.50 | ........ | 10 | 10 | ........ |

### CAPITAL INVESTED.

| STATES AND TERRITORIES | Total value. | In land. | In buildings, machinery, etc. | In tools, implements, live stock, etc. | Cash. |
|---|---|---|---|---|---|
| Total | $259,475 | $179,800 | $41,350 | $27,325 | $11,000 |
| Rhode Island | 30,000 | 10,000 | 12,000 | 5,000 | 3,000 |
| New York | 95,000 | 50,000 | 25,000 | 20,000 | ........ |
| Pennsylvania | 14,800 | 10,000 | 4,000 | 800 | ........ |
| Michigan and Wyoming | 119,675 | 109,800 | 350 | 1,525 | 8,000 |

### MOTIVE POWER.

| STATES AND TERRITORIES. | BOILERS. | | WATER MOTORS. | | Number of animals employed. |
|---|---|---|---|---|---|
| | Number. | Total horse power. | Number. | Horse power. | |
| Total | 6 | 355 | 1 | 150 | 7 |
| Rhode Island | 1 | 125 | ........ | ........ | ........ |
| New York | 2 | 120 | 1 | 150 | 3 |
| Pennsylvania | 2 | 90 | ........ | ........ | 2 |
| Michigan and Wyoming | 1 | 20 | ........ | ........ | 2 |

## PRODUCTION IN PREVIOUS YEARS.

With the single exception of the mines in New York state, the production of graphite during the past decade has been very spasmodic, and little authentic information can be obtained respecting the amount and value of the product of other localities. The product of crude graphite in 1880 amounted to 940 short tons, worth $49,800, as given in the Tenth Census reports. Those for subsequent years are returns for refined graphite made by the division of mining statistics of the United States geological survey.

### PRODUCTION OF REFINED GRAPHITE FROM 1881 TO 1888.

[Pounds.]

| YEARS. | Quantity. | Value. |
|---|---|---|
| 1881 | 400,000 | $30,000 |
| 1882 | 425,000 | 34,000 |
| 1883 | 575,000 | 46,000 |
| 1884 | (*a*) | ........ |
| 1885 | 327,883 | 26,231 |
| 1886 | 415,525 | 33,242 |
| 1887 | 416,000 | 34,000 |
| 1888 | 400,000 | 33,000 |

*a* Practically nothing.

## USES.

From the fact that the very common and useful utensils known as lead pencils are made from graphite the name of black lead has been popularly bestowed upon the mineral. Until a comparatively recent date the use of graphite has been confined to this purpose, to the manufacture of crucibles, and to various preparations for stove polishing, etc. Of late, however, other qualities have been observed, which have opened to the mineral entirely new and extensive fields of usefulness, prominent among which is its consumption as a lubricant. For the bearings of heavy machinery it makes a superior lubricant to oil, is clean, leaves no dripping grease, and one proper application will last as long as the bearings themselves. When the discovery was first made that graphite could be so utilized, some difficulty was encountered in keeping the lubricant in place. As originally employed it was mixed with oil and applied to smooth-surfaced bearings; but, though answering the purpose excellently for awhile, it would creep out and escape, and required constant renewals. This was obviated by the introduction of grooved bushings, the grooves being filled with a composition 75 per cent graphite. The box requires no refilling, and the bearings need no new application until the box is worn out. Graphite bushings of this kind were first applied in 1883 and are growing in favor, being now in very general use. Graphite is also used to a considerable extent for foundry facings and washes, also as a substitute for red lead in making joints and connections, having an advantage over red lead in that it does not harden, making a perfectly tight joint, that opens easily when the pipe tongs are applied. It is also said to make a good, durable paint for the covering of smokestacks, boilers, tin roofs, and other metal surfaces.

## IMPORTS.

The following table shows the quantity and value of graphite imported and entered for consumption in the United States from 1867 to 1889, inclusive:

GRAPHITE IMPORTED INTO THE UNITED STATES FROM 1867 TO 1889, INCLUSIVE.

| YEARS ENDED— | Total. | UNMANUFACTURED. | | Manufactured. (Value.) |
|---|---|---|---|---|
| | | Quantity. (Cwt.) | Value. | |
| June 30, 1867 | $54, 131 | 27, 713 | $54, 131 | ............ |
| 1868 | 149, 083 | 68, 620 | 149, 083 | ............ |
| 1869 | 351, 004 | 74, 846 | 351, 004 | ............ |
| 1870 | 270, 124 | 80, 795 | 269, 291 | $833 |
| 1871 | 139, 954 | 51, 628 | 136, 200 | 3, 754 |
| 1872 | 329, 030 | 96, 381 | 329, 030 | ............ |
| 1873 | 548, 613 | 157, 539 | 548, 613 | ............ |
| 1874 | 382, 591 | 111, 992 | 382, 591 | ............ |
| 1875 | 122, 050 | 46, 492 | 122, 050 | ............ |
| 1876 | 168, 314 | 50, 589 | 150, 709 | 17, 605 |
| 1877 | 222, 721 | 75, 361 | 204, 630 | 18, 091 |
| 1878 | 171, 666 | 60, 244 | 154, 757 | 16, 909 |
| 1879 | 188, 650 | 65, 662 | 164, 013 | 24, 637 |
| 1880 | 300, 963 | 109, 908 | 278, 022 | 22, 941 |
| 1881 | 413, 640 | 150, 927 | 381, 966 | 31, 674 |
| 1882 | 389, 371 | 150, 421 | 363, 835 | 25, 536 |
| 1883 | 383, 670 | 154, 893 | 361, 949 | 21, 721 |
| 1884 | 288, 256 | 144, 086 | 286, 393 | 1, 863 |
| 1885 | 207, 228 | 110, 462 | 207, 228 | ............ |
| 1886 | 164, 111 | 83, 368 | 164, 111 | ............ |
| 1887 | 331, 621 | 168, 841 | 331, 621 | ............ |
| Dec. 31, 1888 | 353, 990 | 184, 013 | 353, 990 | ............ |
| 1889 | 378, 057 | 177, 381 | 378, 057 | ............ |

# SOAPSTONE.

# SOAPSTONE.

BY E. W. PARKER.

## VARIETIES AND OCCURRENCE.

Soapstone, or talc, is a hydrated silicate of magnesia, soft, with a soapy feeling, to which it owes its name. There are two principal varieties of the mineral, 1 occurring in massive form, and known as steatite, soapstone, potstone, rensselaerite, etc., the other foliated and fibrous, and not dissimilar in appearance to asbestos. This latter variety, known as fibrous talc, occurs, so far as known, in but one locality in the United States, near the town of Gouverneur, Saint Lawrence county, New York. The ordinary or massive form is distributed liberally throughout the country, and is found in a number of places in Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, New York, New Jersey, Pennsylvania, Maryland, Virginia, North Carolina, South Carolina, Georgia, Alabama, Texas, Arizona, and South Dakota. The two varieties are used for entirely different purposes and are treated separately in this report.

## PRODUCTION.

The amount of ordinary soapstone produced in the United States in 1889 was 12,715 short tons, valued at $231,708, which represents the aggregate amount received by operators for their product. In some cases the mineral is sold rough or without further preparation than being sawed into slabs convenient for shipping, and in such condition the price ranges between $7 and $10 per ton. About 50 per cent of the entire product is manufactured before being placed upon the market, and the table showing its production is arranged to indicate how much was sold rough or sawed and how much was manufactured, with the value of each. In all instances the labor and wages involved and the capital invested apply to the condition of the product as marketed.

PRODUCTION OF SOAPSTONE IN 1889, BY STATES.

[Short tons.]

| STATES. | Total product. | CONDITION IN WHICH PRODUCT WAS FIRST SOLD. | | | | Total value. |
|---|---|---|---|---|---|---|
| | | Crude. | Value. | Manufactured. | Value. | |
| Total | 12,715 | 6,303 | $51,575 | 6,412 | $180,133 | $231,708 |
| Maryland | 432 | 432 | 4,321 | | | 4,321 |
| New Hampshire | 4,252 | | | 4,252 | 117,883 | 117,883 |
| New Jersey | 1,500 | 1,500 | 10,262 | | | 10,262 |
| Pennsylvania | 4,371 | 4,371 | 36,992 | | | 36,992 |
| Vermont | 900 | | | 900 | 20,000 | 20,000 |
| Virginia | 1,260 | | | 1,260 | 42,250 | 42,250 |

## LABOR AND WAGES.

The highest compensation for foremen was $4 per day, paid in New Hampshire; for mechanics, $2.50 per day, paid in Virginia. Laborers received the highest wages in Vermont, the rate at one quarry being $1.50 per day. The lowest rates per day were as follows: for foremen, $1.50, in New Jersey and Pennsylvania; mechanics, $1, in Virginia; laborers, 75 cents, in Virginia. Boys received the uniform rate of 75 cents per day.

LABOR EMPLOYED AT SOAPSTONE QUARRIES IN 1889, BY STATES, EXCLUSIVE OF FIBROUS TALC OPERATIONS.

| STATES. | AVERAGE NUMBER EMPLOYED. | | | | AVERAGE WAGES PER DAY. | | | | AVERAGE NUMBER OF DAYS WORKED. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Foremen. | Mechanics. | Laborers. | Boys. | Foremen. | Mechanics. | Laborers. | Boys. | Foremen. | Mechanics. | Laborers. | Boys. |
| Total | 20 | 71 | 177 | 12 | $2.60 | $1.87 | $1.28 | $0.75 | 282 | 286 | 275 | 263 |
| New Hampshire | 4 | 45 | 54 | .......... | 3.62 | 1.90 | 1.40 | .......... | 303 | 298 | 292 | .......... |
| Pennsylvania | 4 | 2 | 28 | 2 | 1.50 | 1.75 | 1.25 | 0.75 | 269 | 281 | 274 | 200 |
| Vermont | 3 | 10 | 19 | .......... | 2.00 | 1.50 | 1.38 | .......... | 223 | 260 | 237 | .......... |
| Virginia | 7 | 14 | 61 | 10 | 3.07 | 2.07 | 1.16 | 0.75 | 286 | 268 | 272 | 275 |
| Other states (*a*) | 2 | .......... | 15 | .......... | 2.00 | .......... | 1.21 | .......... | 337 | .......... | 272 | .......... |

*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Maryland and New Jersey.

OPERATING EXPENSES.

| STATES. | Total expenditures. | Wages, including office force. | Paid contractors. | Paid for supplies. | Other expenditures. |
|---|---|---|---|---|---|
| Total | $163,438 | $115,621 | $4,023 | $35,454 | $8,340 |
| New Hampshire | 75,750 | 49,927 | 3,423 | 20,000 | 2,400 |
| Pennsylvania | 24,907 | 13,078 | .............. | 11,104 | 725 |
| Vermont | 12,300 | 9,700 | 600 | 1,000 | 1,000 |
| Virginia | 41,537 | 36,287 | .............. | 2,900 | 2,350 |
| Other states (*a*) | 8,944 | 6,629 | .............. | 450 | 1,865 |

*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Maryland and New Jersey.

CAPITAL INVESTED.

| STATES. | Total value. | In land. | In buildings, machinery, etc. | In tools, implements, live stock, etc. | Cash. |
|---|---|---|---|---|---|
| Total | $924,900 | $431,500 | $86,100 | $92,300 | $15,000 |
| Georgia (*a*) | 250,000 | 200,000 | 25,000 | 25,000 | ............ |
| New Hampshire | *b*350,000 | 30,000 | 8,000 | 7,000 | 5,000 |
| North Carolina (*a*) | 110,000 | 104,000 | 2,000 | 4,000 | ............ |
| Pennsylvania | 54,300 | 32,500 | 6,100 | 14,700 | 1,000 |
| Vermont | 20,000 | 10,000 | 5,000 | 2,000 | 3,000 |
| Virginia | 112,000 | 44,000 | 28,000 | 34,000 | 6,000 |
| Other states (*c*) | 28,600 | 11,000 | 12,000 | 5,600 | ............ |

*a* No operations in 1889.
*b* Of this amount $300,000 is represented by capital stock paid in, not distributed.
*c* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Maryland and New Jersey.

## USES.

The uses for soapstone at the present day are many and various. When exposed to fire or to changes of atmosphere it is one of the most durable substances known, expanding and contracting very little, even at extreme degrees of heat or cold. For this reason it is used very extensively instead of fire brick in the construction of furnaces for the reduction of ores by fluxes, for crucibles, and the linings of boilers, ranges, and heaters. One of its principal uses is for the manufacture of laundry, bath, and acid tubs. It does not absorb acid or grease, and is easily cleansed of any adherent impurities by washing. Soapstone is now receiving some attention as a material for the manufacture of fireproof, waterproof, and acidproof paint. For this purpose it is useful as a protective covering for iron and steel ships and other marine structures, for preserving limestone and sandstone structures against atmospheric changes, and in a number of similar ways. In this application of soapstone to the arts it may be said that the civilization of China has shown greater advancement than that of the western hemisphere. In China soapstone is largely used for preserving structures built of sandstone and other stones which are liable to disintegrate under atmospheric influences, and the covering of powdered soapstone in the form of paint on some obelisks in China, which were hewn out of stones liable to suffer from climatic changes, is said to have preserved the same intact for hundreds of years. Soapstone possesses one peculiar quality which fits it for the manufacture of a protective paint for metals, and that is the extreme fineness of its grain. Ground soapstone is one of the finest materials which can be produced, and adheres easily and firmly to iron and steel. Moreover, it is lighter than metallic pigments, and if mixed as a paint will cover a larger surface than zinc white, red lead, or oxide of iron. It is used as a lubricant in the form of what is known as steatite grease, and is said to be invaluable as a preventive of hot boxes. It finds some use as a base for cosmetics, for polishing glass and marble, and for the manufacture of interior wall coverings, and is also made into slate pencils. In Alabama soapstone is used for headstones, and it makes excellent hearths, griddles, and mantels. It is also used for dressing skins, leather, etc., and as an adulterant in the manufacture of soap, paper, and rubber. Possessing no poisonous or injurious constituents, it is, therefore, not harmful as an adulterant, except in reference to honesty in weight. Soapstone was used to a very large extent by the Indians of North America, and Dr. W. H. Holmes, of the United States geological survey, who has been for some time engaged in the investigation of that subject, has kindly furnished the following interesting data concerning it:

> Among the many varieties of rocks utilized by the American aborigines soapstone took a prominent place. The advantage of a mineral that would withstand measurably the action of fire was no doubt recognized at a very early period, and the fact that it was so easily reduced to desired shapes led first to the production of vessels for cooking and boiling and afterward to the manufacture of pipes and many fanciful forms used in councils and religious ceremonies and in medicinal arts.
>
> The quarrying and working of soapstone by the native races were most extensively practiced along the coast of California, but there are few known localities of this material where some traces of native operations have not been found. The broad soapstone-bearing belt which extends along the Atlantic slope from Maine to Georgia abounds in ancient quarries, and upon a single site within the suburbs of Washington city many pits are still traceable and thousands of fragments of partially finished pots occur upon the surface of the ground and throughout the soil and débris. Many of these ancient quarries have been reworked by the whites, and in numerous cases the traces of aboriginal work have been wholly obliterated.
>
> The natives employed rude tools of stone, and probably also of wood and bone, or antler, in their mining operations. Owing to the massiveness and toughness of the rock, and the difficulty of removing the accumulations of earth and débris, they seldom penetrated to a depth of more than a few feet. Masses of suitable size were broken off or were separated from the bed by the laborious process of picking with stone tools. With smaller picks and chisels of slate, quartz, quartzite, and tough volcanic rocks the bowls of the utensils were roughed out on the quarry site. The half-finished vessels were carried away to dwelling sites and were there finished at leisure by means of small chisels, scrapers, and rubbing stones. At best the vessels are heavy and rather rude as compared with earthen vessels of the same region. Native pipes made of this material are often elaborate and handsome in shape, and of exquisite finish.

# FIBROUS TALC.

The fibrous variety of talc or soapstone quarried at Gouverneur, New York, is especially valuable as a filler in the manufacture of paper. One of its valuable characteristics in this respect is its light bluish tinge, which gives to the paper an excellent white color. It is not used in the very finest papers, nor in the coarsest grades, but is consumed to a large extent in the intermediate qualities. Its light weight and fibrous nature admit of its almost entire incorporation with the other ingredients of paper manufacture. The production of fibrous talc at Gouverneur, New York, in 1889 was 23,746 tons, valued at $244,170.

## PROCESS OF PREPARATION.

In preparing the talc to be used for making paper it is first crushed into pieces small enough to be ground by buhrstones. After grinding, it is placed, with a quantity of flint pebbles, in large iron cylinders lined with porcelain, and the talc is reduced to the desired fineness by friction against the sides of the cylinders and the pebbles. It is then packed and delivered to the trade under various names, such as mineral pulp, asbestine pulp, agalite, etc.

## INCREASE IN THE PAST DECADE.

By comparing the product of soapstone and fibrous talc for the year 1889 with that of the Tenth Census year it will be observed that there is a gain in the quantity of the former of about 51 per cent. The increase in value is 248 per cent. This large percentage is probably due to the amount of soapstone produced in 1889 which was sold in the manufactured state. The percentage of increase in the product of fibrous talc is 464 per cent, and in value 346 per cent.

The following table shows the product and value of 1880 as compared with that of 1889, by states:

COMPARATIVE STATISTICS OF SOAPSTONE FOR 1880 AND 1889, BY STATES.

| STATES. | PRODUCT. (Short tons.) | | Increase. (Short tons.) | Decrease. (Short tons.) | VALUE. | | Increase. | Decrease. |
|---|---|---|---|---|---|---|---|---|
| | 1880. | 1889. | | | 1880. | 1889. | | |
| Total | 8,441 | 12,715 | 4,274 | | $66,665 | $231,708 | $165,043 | |
| Georgia | 320 | | | 320 | 710 | | | $710 |
| Maryland | 300 | 432 | 132 | | 1,950 | 4,321 | 2,371 | |
| New Hampshire | 2,000 | 4,252 | 2,252 | | 30,000 | 117,883 | 87,883 | |
| New Jersey | | 1,500 | 1,500 | | | 10,262 | 10,262 | |
| North Carolina | 510 | | | 510 | 5,100 | | | 5,100 |
| Pennsylvania | 4,011 | 4,371 | 360 | | 17,055 | 36,992 | 19,937 | |
| Vermont | 1,300 | 900 | | 400 | 11,850 | 20,000 | 8,150 | |
| Virginia | | 1,260 | 1,260 | | | 42,250 | 42,250 | |

| STATES. | TOTAL NUMBER OF EMPLOYÉS. | | TOTAL WAGES PAID. | | OTHER EXPENSES. | | TOTAL EXPENSES. | |
|---|---|---|---|---|---|---|---|---|
| | 1880. | 1889. | 1880. | 1889. | 1880. | 1889. | 1880. | 1889. |
| Total | 113 | 280 | $29,455 | $115,621 | $2,841 | $47,817 | $32,296 | $163,438 |
| Georgia | 12 | | 390 | | 100 | | 490 | |
| Maryland | 4 | 5 | 734 | 2,245 | 114 | 265 | 848 | 2,510 |
| New Hampshire | 30 | 103 | 12,000 | 49,927 | 950 | 25,823 | 12,950 | 75,750 |
| New Jersey | | 12 | | 4,384 | | 2,050 | | 6,434 |
| North Carolina | 15 | | 2,500 | | | | 2,500 | |
| Pennsylvania | 27 | 36 | 7,931 | 13,078 | 552 | 11,829 | 8,483 | 24,907 |
| Vermont | 25 | 32 | 5,900 | 9,700 | 1,125 | 2,600 | 7,025 | 12,300 |
| Virginia | | 92 | | 36,287 | | 5,250 | | 41,537 |

TALC IMPORTED INTO THE UNITED STATES FROM 1880 TO 1889, INCLUSIVE.

[Pounds.]

| YEARS. | Quantity. | Value. |
|---|---|---|
| 1880 | | $22,807 |
| 1881 | | 7,331 |
| 1882 | | 25,641 |
| 1883 | | 14,607 |
| 1884 | | 41,165 |
| 1885 | | 24,356 |
| 1886 | | 24,514 |
| 1887 | | 49,250 |
| 1888 | *a*24,165 | 22,446 |
| 1889 | 19,229 | 30,993 |

*a* Quantity not reported previous to 1888.

# BARYTES.

# BARYTES.

BY E. W. PARKER.

Barytes, or natural barium sulphate, is a well-known mineral and liberally distributed, but it is only recently that it has become of any commercial importance. Barium sulphate has been prepared artificially for a number of years, and is used to a considerable extent in the place of white lead, which it resembles closely. Improvements in machinery and in the processes of treating natural barytes have overcome many of the objections which formerly existed to its utilization, and considerable attention is now being given to the localities in the United States where it is found. The mineral, in order to be available for the uses to which it is put, must be fairly free from quartz grains, the stain of iron rust, or other impurities. If the barytes is stained to any extent it is practically valueless, as a good white color is essential to its usefulness. Quartz grains or other hard substances with which it is apt to be associated injure the machinery in grinding. The purest barytes so far produced in this country comes from Missouri, though a very fair grade is now being mined in considerable quantities in Virginia.

## PRODUCTION IN 1889.

The returns from all producers of crude barytes show a product in the United States for 1889 of 21,460 short tons, valued at $106,313, against 22,400 short tons in 1888, valued, approximately, at $110,000.

The production was limited to four states, as shown in the following table:

PRODUCTION OF BARYTES IN 1889, BY STATES.

[Short tons.]

| STATES. | Quantity. | Value. |
|---|---|---|
| Total | 21,460 | $106,313 |
| Illinois | 200 | 1,300 |
| Missouri | 7,558 | 32,715 |
| North Carolina | 3,000 | 15,000 |
| Virginia | 10,702 | 57,298 |

## LABOR AND WAGES.

Barytes mining in Missouri is carried on in such a very irregular manner that it is impossible to obtain any reliable statistics relative to labor and wages. Farmers mine it in off seasons; that is, when there is no farming to do they employ themselves and their hands in getting out the barytes found on their farms, haul it to the nearest tradesman, and receive in exchange dry goods, groceries, or other necessaries, or cash. The farmers thus occupy time which would otherwise be idle, and dispose of the barytes at a less figure than it would pay to mine it systematically. The supply thus obtained is nearly sufficient to keep the mills up to their fullest capacity.

A few mines are, however, operated with some degree of system, though for want of proper records it is necessary to estimate a considerable portion of the matter of labor and wages. The mines altogether give irregular employment to about 580 men. The rate of compensation for foremen is about $2.50 per day, and for laborers from $1 to $1.50 per day. It is rarely, however, that the men make full time, and their daily earnings are reported at from 50 to 75 cents. From 75 to 100 women obtain the same sort of irregular employment, earning about 35 cents per day. Boys get from 25 to 30 cents per day. One mine was active nearly the entire year, but in most cases the number of days worked at the mines ranged from 125 to 200. One mine in Illinois employed 10 men and 2 women for 52 days.

The number of men employed in Virginia and North Carolina and the average wages paid each class are shown in the following table:

NUMBER OF EMPLOYÉS AND WAGES PAID AT BARYTES MINES IN VIRGINIA AND NORTH CAROLINA.

| EMPLOYÉS. | Average number employed. | Average wages per day. | Average number of days worked. |
|---|---|---|---|
| Total | 215 | | |
| Foremen (*a*) | 11 | $1.70 | 220 |
| Mechanics (*b*) | 7 | 1.43 | 20 |
| Miners | 85 | 0.85 | 290 |
| Laborers (*c*) | 107 | 0.68 | 225 |
| Boys under 16 years of age | 5 | 0.35 | 22 |

*a* Of the foremen, 4 were employed above ground, and 7 below.
*b* All above ground.
*c* Of the laborers, 29 were employed above ground and 78 below.

## OPERATING EXPENSES.

The following statement shows the amount of money paid for operating and developing barytes mines in Virginia, North Carolina, and Illinois:

WAGES AND OTHER EXPENDITURES AT BARYTES MINES IN VIRGINIA, NORTH CAROLINA, AND ILLINOIS.

| | |
|---|---|
| Wages (including office force at mines) | $54,524 |
| Paid for supplies | 8,200 |
| Other expenditures (rent, taxes, insurance, etc.) | 2,083 |
| Total | 64,807 |

## CAPITAL.

The amount of capital represented in barytes mines in the United States is shown in the following statement, and only refers to such properties as were worked in 1889. The aggregate value of the lands on which barytes is found in Missouri is placed at $4,500,000, but the estimates are based on prospects rather than on actual development.

CAPITAL INVESTED IN BARYTES MINES IN THE UNITED STATES.

| | |
|---|---|
| In land | $184,450 |
| In buildings, machinery, etc | 66,450 |
| In tools, implements, live stock, etc | 76,350 |
| Cash | 23,900 |
| Total | 351,150 |

## USES.

The consumption of barytes seems to be steadily increasing. It is used quite extensively in the arts, finding its greatest service as an adulterant in the manufacture of paint. Its great weight, its likeness in many respects to white lead, and the fact that it can be used in place of that commodity, enables manufacturers to replace the costlier article with a substitute, much to their own advantage. It is claimed by some that a mixture composed of one-third barytes, one-third zinc white, and one-third white lead makes a better paint than the pure white lead. This is probably true for some special purposes. Barytes is remarkable for its weight, having a specific gravity of about 4.5, or about the same as iron ore. It can therefore be used with white lead without any appreciable loss of weight in the mixture.

## PROCESS OF MANUFACTURE.

In the Mineral Resources of the United States for 1885 a brief description is given of the process of manufacturing or floating barytes. The processes have not materially changed since that date, and are about as follows:

The crude barytes, having first been assorted and cleaned, is ground or crushed to about the size of buckshot. It is then treated with sulphuric acid, for the purpose of removing iron stains and other impurities with which barytes is apt to be discolored, and afterward boiled in distilled water, dried by steam, and pulverized. The pulverized barytes is then placed in large vats and mixed with water, and part of the mixture settles rapidly. That which floats longest is the best suited for the manufacture of paint, and is drawn off, dried again by steam, and is then barreled and ready for market. It is thus that the name "floated barytes" is derived. The floated barytes finds a steady market at from $19 to $32 per ton, according to quality, purity of color, etc.

## NEW DEVELOPMENTS.

Besides the localities from which the supply has been thus far derived, there are deposits in South Carolina which are now being investigated with prospects of development at an early date. The mineral is found along the line of the Charleston, Cincinnati and Chicago railroad, in the building of which a considerable vein was exposed, but occurs in largest quantities in the vicinity of Kings Creek, where a side track can be run in and the material loaded on cars. Lack of transportation was one of the drawbacks to its development in the past, but this difficulty has been removed by the railroad builders. Diffused through the barytes is a small percentage of quartz grains, which make it necessary to use other grinding machinery than the buhr mills ordinarily used for that purpose. It is expected that mills for this purpose will be put up in the vicinity of the mines, thereby insuring a more profitable business than can be obtained by sending the barytes elsewhere to be ground and floated.

At Terrazas station, state of Chihuahua, Mexico, there are some 6 or 8 veins of barytes from 1 to 5 feet thick, said to be of a good white color, free from yellow, brown, or black iron stains, and a considerable portion of which is a very delicate pale-blue tint, considered valuable in the highest classes of barytes, as it tends to neutralize the yellowish tint of inferior qualities. The company owning the property upon which these veins are found offered to sell the barytes in car loads at $5 per short ton, free on board cars at the shipping point.

The following table shows the production of barytes since 1882. No statistics have been published prior to that year.

PRODUCT OF CRUDE BARYTES FROM 1882 TO 1889, INCLUSIVE.(*a*)

[Short tons.]

| YEARS. | Quantity. | Value. |
|---|---|---|
| 1882 | 22,400 | $80,000 |
| 1883 | 30,240 | 108,000 |
| 1884 | 28,000 | 100,000 |
| 1885 | 16,800 | 75,000 |
| 1886 | 11,200 | 50,000 |
| 1887 | 16,800 | 75,000 |
| 1888 | 22,400 | 110,000 |
| 1889 | 21,460 | 106,313 |

*a* The production given for years previous to 1889 is mostly estimated, and the figures are probably slightly exaggerated.

## IMPORTS.

Nearly all, if not all, of the barium sulphate imported into the United States is artificially prepared. Importations are quoted under various names, such as blanc-fixe, or permanent white, satin white, enameled white, lime white, etc.

IMPORTS OF BARIUM SULPHATE FROM 1867 TO 1889, INCLUSIVE.

[Pounds.]

| YEARS ENDED— | MANUFACTURED. | | UNMANUFACTURED. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| June 30, 1867 | 14,968,181 | $141,273 | | |
| 1868 | 2,755,547 | 26,739 | | |
| 1869 | 1,117,335 | 8,565 | | |
| 1870 | 1,684,916 | 12,917 | | |
| 1871 | 1,385,004 | 9,769 | | |
| 1872 | 5,804,098 | 43,521 | | |
| 1873 | 6,939,425 | 53,759 | | |
| 1874 | 4,788,966 | 42,235 | | |
| 1875 | 2,117,854 | 17,995 | | |
| 1876 | 2,655,349 | 25,325 | | |
| 1877 | 2,388,373 | 19,273 | | |
| 1878 | 1,366,857 | 10,340 | | |
| 1879 | 453,333 | 3,496 | | |
| 1880 | 4,924,423 | 37,374 | | |
| 1881 | 1,518,322 | 11,471 | | |
| 1882 | 562,300 | 3,856 | | |
| 1883 | 411,666 | 2,489 | | |
| Dec. 31, 1884 | 3,884,516 | 24,671 | 5,800,816 | $8.044 |
| 1885 | 4,095.287 | 20,608 | 7,841,715 | 13,567 |
| 1886 | 3,476,691 | 18,338 | 6,588,872 | 8,862 |
| 1887 | 4,057,831 | 19,769 | 10,190,848 | 13,205 |
| 1883 | 3.821,842 | 17,135 | 6,504,975 | 9,037 |
| 1839 | 3,601.506 | 22,458 | 13,571,206 | 7,660 |

# OCHER AND METALLIC PAINT.

# OCHER AND METALLIC PAINT.

BY E. W. PARKER.

For commercial purposes it has become customary to separate pigments manufactured from iron oxides into two classes, viz, "ocher" and "metallic paint". The former term is usually applied to paints made from clays to which the natural mixing of iron peroxide and water has imparted a bright-red or reddish-yellow color, and the latter to the darker red and brown paints manufactured from iron ores. These distinctions are adhered to in this report.

## OCHER.

The production of ocher for 1880, as obtained by the Tenth Census, was 4,037 tons, valued at $135,840. The product in 1889 was 15,158 tons, valued at $177,472, showing an increase in tonnage of 275 per cent and an increase in value of only about 31 per cent. This difference in tonnage and value is, in all probability, due to the values of the product being taken at different stages of manufacture. The high estimate placed upon the product of 1880 would indicate that prices were taken for the manufactured article, whereas the values in the present investigation were obtained for the mineral in the condition in which it was first sold, freights eliminated.

The statement of the production by states in 1880, as compared with that of 1889, is shown in the following table:

COMPARATIVE PRODUCTION OF OCHER FOR 1880 AND 1889, BY STATES.

[Short tons.]

| STATES. | 1880. | | 1889. | |
|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. |
| Total | 4, 037 | $135, 840 | 15, 158 | $177, 472 |
| Alabama | | | 336 | 3, 500 |
| Colorado | | | 50 | 150 |
| Georgia | | | 2, 512 | 29, 720 |
| Maryland | | | 616 | 12, 000 |
| Massachusetts | | | 80 | 750 |
| New Jersey | 300 | 1, 350 | | |
| Pennsylvania | | | 7, 922 | 103, 797 |
| Vermont | 1, 750 | 27, 750 | 1, 884 | 7, 800 |
| Virginia | 1, 987 | 106, 740 | 1, 658 | 18, 755 |
| Wisconsin | | | 100 | 1, 000 |

### PRODUCTION IN OTHER YEARS.

According to Mineral Resources of the United States, the amount of ocher produced in this country from 1881 to 1886 was estimated at about 7,000 tons annually. This was increased in 1887 to 8,000 tons, and a further increase to 10,000 tons was noted in 1888. The difference of 5,158 tons between the estimated product for 1888 and the amount shown by the census returns indicates that the estimates for previous years were considerably less than the actual production.

## LABOR AND WAGES.

The following tables show the number of men employed at ocher mines in the United States in 1889, the average wages per day, the number of days worked, the operating expenses, and capital invested:

### MEN EMPLOYED AND WAGES PAID AT OCHER MINES IN 1889, BY STATES.

| STATES. | FOREMEN. | | | MECHANICS. | | | LABORERS. | | | BOYS UNDER 16 YEARS. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Total | 17 | $2.07 | 236 | 14 | $1.68 | 264 | 162 | $1.12 | 228 | 3 | $0.50 | 200 |
| Georgia | 2 | 2.35 | 300 | 2 | 1.25 | 220 | 25 | 1.00 | 188 | | | |
| Pennsylvania | 6 | 1.77 | 290 | 8 | 1.75 | 300 | 61 | 1.18 | 291 | | | |
| Vermont | 1 | 1.33 | 300 | | | | 15 | 1.11 | 195 | | | |
| Virginia | 3 | 1.67 | 225 | 4 | 1.75 | 213 | 31 | 1.00 | 207 | | | |
| Wisconsin | 1 | 5.00 | 20 | | | | 3 | 2.50 | 20 | | | |
| Other states (*a*) | 4 | 2.15 | 170 | | | | 27 | 1.06 | 188 | [illegible] | 0.50 | 200 |

*a* The states here grouped, in order that the business of individual establishments may not be disclosed, embrace Alabama, Colorado, Maryland, and Massachusetts.

### OPERATING EXPENSES.

| STATES. | Grand total expenditures. | Total wages, including office force. | Paid for supplies. | Other expenditures. |
|---|---|---|---|---|
| Total | $86,247 | $59,695 | $19,011 | $7,541 |
| Georgia | 12,491 | 7,006 | 3,960 | 1,525 |
| Pennsylvania | 41,536 | 29,966 | 10,096 | 1,474 |
| Vermont | 6,670 | 3,623 | 1,280 | 1,767 |
| Virginia | 14,080 | 10,780 | 2,550 | 750 |
| Wisconsin | 365 | 250 | 115 | |
| Other states (*a*) | 11,105 | 8,070 | 1,010 | 2,025 |

*a* The states here grouped, in order that the business of individual establishments may not be disclosed, embrace Alabama, Colorado, Maryland, and Massachusetts.

### CAPITAL INVESTED.

| STATES. | Total. | In land. | In buildings, machinery, etc. | In tools, etc. | Cash. |
|---|---|---|---|---|---|
| Total | $386,453 | $249,560 | $68,693 | $45,750 | $22,450 |
| Georgia | 89,000 | 47,500 | 21,600 | 14,900 | 5,000 |
| Pennsylvania | 60,600 | 40,900 | 14,500 | 4,500 | 700 |
| Vermont | 12,510 | 6,810 | 3,600 | 2,100 | |
| Virginia | 30,000 | 13,000 | 7,500 | 4,000 | 5,500 |
| Wisconsin | 15,000 | 10,000 | 3,500 | 1,500 | |
| Other states (*a*) | 179,343 | 131,350 | 17.993 | 18,750 | 11,250 |

*a* The states here grouped, in order that the business of individual establishments may not be disclosed, embrace Alabama, Colorado, Maryland, and Massachusetts.

## METALLIC PAINT.

There are no statistics of the production of metallic paint published in the mining volume of the Tenth Census. In 1856 the discovery of an iron ore valuable for the manufacture of metallic paint was made in Carbon county, Pennsylvania, near the Lehigh river, and at no time since the original discovery have the mines been idle. The production in the United States in 1889 from all sources amounted to 21,026 short tons, valued at $286,294, as follows:

PRODUCTION OF METALLIC PAINT IN THE UNITED STATES IN 1889, BY STATES.

[Short tons.]

| STATES. | Quantity. | Value. |
|---|---|---|
| Total | 21, 026 | $286, 294 |
| Alabama | 3, 000 | 30, 000 |
| Colorado | 90 | 2, 500 |
| New York | 3, 658 | 63, 698 |
| Ohio | 540 | 11, 123 |
| Pennsylvania | 8, 849 | 128, 036 |
| Tennessee | 3, 057 | 24, 237 |
| Wisconsin | 1, 832 | 26, 700 |

## LABOR AND WAGES.

The following table is arranged to show by states the number of men employed at metallic paint mines, the average wages paid, and the number of days worked by each class of employés:

LABOR EMPLOYED AT METALLIC PAINT MINES IN THE UNITED STATES IN 1889, BY STATES.

| STATES. | FOREMEN. | | | MECHANICS. | | | LABORERS. | | | BOYS UNDER 16 YEARS. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. | Average number employed. | Average wages per day. | Average number of days worked. |
| Total | 10 | $2. 42 | 250 | 27 | $1. 90 | 262 | 151 | $1. 34 | 250 | 3 | $0. 67 | 97 |
| New York | 2 | 3. 00 | 300 | 4 | 1. 73 | 171 | 22 | 1. 44 | 204 | 1 | 1. 00 | 175 |
| Ohio | 2 | 2. 25 | 181 | 1 | 2. 00 | 150 | 10 | 1. 43 | 139 | | | |
| Pennsylvania (*a*) | 1 | 1. 25 | 276 | 16 | 1. 81 | 295 | 83 | 1. 30 | 281 | | | |
| Tennessee | 1 | 2. 50 | 300 | 1 | 2. 00 | 300 | 13 | 1. 16 | 254 | | | |
| Wisconsin | 2 | 2. 21 | 214 | 3 | 2. 33 | 228 | 10 | 1. 60 | 134 | 2 | 0. 50 | 58 |
| Other states (*b*) | 2 | 2. 75 | 268 | 2 | 2. 25 | 268 | 13 | 1. 31 | 295 | | | |

*a* Under laborers are included 25 miners at $1.40 per day and 12 laborers at $1.25 per day (300 days each) below ground.

*b* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Alabama and Colorado.

## OPERATING EXPENSES.

| STATES. | Total paid for labor. | OFFICE FORCE. | | | | Grand total expenditures. | Grand total of wages. | Total paid contractors. | Paid for supplies. | Other expenditures. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Males. | | Females. | | | | | | |
| | | Number. | Wages paid. | Number. | Wages paid. | | | | | |
| Total | $69, 820 | 7 | $5, 440 | 1 | $100 | $163, 787 | $75, 360 | $8, 674 | $65, 498 | $14, 255 |
| New York | 10, 603 | 1 | 540 | | | 24, 064 | 11, 143 | 5, 146 | 4, 705 | 3, 070 |
| Ohio | 3, 124 | | | | | 3, 173 | 3, 124 | | 14 | 35 |
| Pennsylvania | 38, 047 | 3 | 2, 500 | | | 103, 031 | 40, 547 | 3, 408 | 50, 001 | 9, 075 |
| Tennessee | 4, 950 | | | | | 4, 950 | 4, 950 | | | |
| Wisconsin | 5, 484 | 2 | 1, 800 | 1 | 100 | 19, 057 | 7, 384 | 120 | 9, 978 | 1, 575 |
| Other states (*a*) | 7, 612 | 1 | 600 | | | 9, 512 | 8, 212 | | 800 | 500 |

*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Alabama and Colorado.

## CAPITAL INVESTED.

| STATES. | Total. | In land. | In buildings, machinery, etc. | In tools, etc. | Cash. |
|---|---|---|---|---|---|
| Total | $462, 164 | $222, 100 | $128, 700 | $69, 064 | $42, 300 |
| New York | 86, 164 | 10, 500 | 51, 350 | 18, 314 | 6, 000 |
| Ohio | 60, 000 | 32, 000 | 19,000 | 7, 500 | 1, 500 |
| Pennsylvania | 207, 700 | 126, 500 | 29, 100 | 26, 100 | 26, 000 |
| Tennessee | 20, 200 | 6, 100 | 9, 050 | 4, 050 | 1, 000 |
| Wisconsin | 48, 000 | 28, 500 | 8, 600 | 4, 100 | 6. 800 |
| Other states (*a*) | 40, 100 | 18, 500 | 11, 600 | 9, 000 | 1. 000 |

*a* The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Alabama and Colorado.

# FLUORSPAR.

# FLUORSPAR.

BY E. W. PARKER.

## PRODUCTION.

The production of fluorspar in the United States in 1889 was limited to one locality, near Rosiclare, Illinois. The product was 9,500 tons, valued at $45,835, an increase of 3,500 tons over the product of 1888. There has been little fluctuation in price.

The following table gives the quantity and value of fluorspar produced in the United States for all the years for which figures are obtainable:

PRODUCTION OF FLUORSPAR IN THE UNITED STATES FROM 1882 TO 1889, INCLUSIVE.

[Short tons.]

| YEARS. | Quantity. | Value. |
|---|---|---|
| 1882 | 4,000 | $20,000 |
| 1883 | 4,000 | 20,000 |
| 1884 | 4,000 | 20,000 |
| 1885 | 5,000 | 22,500 |
| 1886 | 5,000 | 22,000 |
| 1887 | 5,000 | 20,000 |
| 1888 | 6,000 | 30,000 |
| 1889 | 9,500 | 45,835 |

## LABOR AND WAGES.

The mining of fluorspar gives employment to about 100 men, who work an average of 200 days in the year. The demand for the mineral is not heavy, and the mines are operated only about two-thirds of the time. The distribution of the men employed and the wages paid each class are shown in the following table:

LABOR AND WAGES.

| EMPLOYÉS. | Average number employed. | Average wages per day. |
|---|---|---|
| Total | 101 | |
| Above ground: | | |
| Foremen | 3 | $2.42 |
| Mechanics | 8 | 1.62 |
| Laborers | 60 | 1.25 |
| Boys under 16 years of age | 2 | 0.50 |
| Below ground: | | |
| Foremen | 1 | 2.00 |
| Miners | 18 | 1.50 |
| Laborers | 9 | 1.25 |

## COST OF PRODUCTION.

The expenses incurred in the mining of fluorspar in the United States for the year 1889 were as follows:

OPERATING EXPENSES.

| | |
|---|---|
| Wages | $14,213 |
| Paid for supplies | 5,025 |
| Other expenses | 3,008 |
| Total | 22,246 |

## CAPITAL INVESTED.

The amount of capital represented in the industry is $192,000, distributed as follows:

### CAPITAL INVESTED.

| | |
|---|---|
| In land | $131,000 |
| In buildings, machinery, etc | 12,500 |
| In tools, implements, live stock, etc | 13,000 |
| Cash used as working capital | 35,500 |
| Total | 192,000 |

## USES.

Fluorspar is used principally as a flux in melting iron in foundries, for the manufacture of opalescent glass, and for producing hydrofluoric acid for chemical purposes.

## IMPORTS.

Fluorspar (calcium fluoride) is not imported into the United States, but is obtained as a by-product in the reduction of cryolite to the salts of aluminum and sodium. All of the cryolite consumed in the United States is imported from Greenland. The amount of cryolite imported into the United States from 1871 to 1889, inclusive, is shown in the following table:

### IMPORTS OF CRYOLITE FOR THE YEARS 1871 TO 1889, INCLUSIVE.

[Long tons.]

| YEARS ENDED— | Quantity. | Value. |
|---|---|---|
| June 30, 1871 | | $71,058 |
| 1872 | | 75,195 |
| 1873 | | 84,226 |
| 1874 | | 28,118 |
| 1875 | | 70,472 |
| 1876 | | 103,530 |
| 1877 | | 126,692 |
| 1878 | | 105,884 |
| 1879 | | 66,042 |
| 1880 | | 91,366 |
| 1881 | | 103,529 |
| 1882 | 3,758 | 51,589 |
| 1883 | 6,508 | 97,400 |
| 1884 | 7,390 | 106,029 |
| Dec. 31, 1885 | 8,275 | 110,750 |
| 1886 | 8,230 | 110,152 |
| 1887 | 10,328 | 138,068 |
| 1888 | 7,388 | 98,830 |
| 1889 | 8,603 | 115,158 |

# LITHOGRAPHIC STONE.

# LITHOGRAPHIC STONE.

BY E. W. PARKER.

In Mineral Resources of the United States for 1886 it is stated that there were promising indications of an early production of domestic lithographic stone to take the place of the Bavarian article, the supply of which is rapidly decreasing. The promise has not been fulfilled. That lithographic stone of good quality and in workable quantity exists in this country there seems to be every reason to believe, but no amount sufficient to be considered a factor in the mining industry has yet been produced, certainly not enough to enter as a competitor with Bavarian stone. During 1886 it is reported that lithographic stone from Clay and Overton counties, Tennessee, was tested by lithographers with highly satisfactory results, but inquiry has failed to discover any records of production since that date. Lithographic stone exists in Blanco and Burnet counties, Texas, and a company has been formed for the purpose of developing the properties in Blanco county.

Mr. H. J. Peyton, of Burnet, Burnet county, reports lithographic stone on his property, but he has not been able to develop it. Mr. Kenneth C. Kerr, special agent of the Census Office, reports a lithographic stone deposit near the town of Santaquin, Utah county, Utah, upon which it was expected to begin operations at an early date. The only locality in the country where lithographic stone was quarried during the year 1889 was in Hardin county, Kentucky, 8 miles northeast of Elizabethtown. The amount of stone taken out was 18 tons, producing 1,200 pounds of the merchantable article, valued at $243. In producing this amount 1 foreman at $1.65 per day and 1 mechanic and 1 laborer at 75 cents each per day were employed. The amount of wages paid was $154. Supplies to the value of $200 were consumed, and $228 was paid for other expenses. As in all cases where only pioneer work has been done, the expenditures were in excess of the value of the product.

Lithographic stone is also reported near the town of Tomahawk, Searcy county, Arkansas, and a company has been organized for the purpose of quarrying it, but had not begun operations up to the close of 1889.

## TESTS OF DOMESTIC STONE.

During the course of the present investigation inquiries were addressed to many of the leading lithographers of the country for the purpose of ascertaining definitely what tests of domestic stone had been made. To these inquiries a large number of replies were received. In a number of instances the tests were highly satisfactory, and specimens of work done upon domestic stone have been submitted, which show to fair advantage. It must be confessed, however, that in many cases the domestic lithographic stone is faulty, sometimes due to the presence of minute crystals of marble or quartz; at other times to different degrees of hardness in the stone itself, rendering it in either case worthless except for cheap work or for the execution of very small designs. It is confidently hoped by those interested in such properties that the imperfections are due to atmospheric influences, affecting only the stone near the surface, and that they will disappear as greater depth is reached. From present indications the supply of Bavarian stone is nearly exhausted, and it is safe to predict that within a few years greater attention will be given to the possibility of American stone furnishing the supply, not only for home consumption but for foreign demand as well.

## FIRMS THAT HAVE TESTED DOMESTIC STONE.

The following lithographers in the United States have tried the qualities of different domestic lithographic stones, with varying results, generally favorable:

Mr. O. V. Greend, New Orleans, Louisiana.
Messrs. Lehman & Bolton, Philadelphia, Pennsylvania.
The Strobridge Lithographing Company, Cincinnati, Ohio.
The Los Angeles Lithographic Company, Los Angeles, California.
The National Bureau of Engraving and Manufacturing Company, Philadelphia, Pennsylvania.
Mr. A. L. Porter, Chicago, Illinois.

## IMPORTS.

The imports of unengraved lithographic stone during late years have been as follows:

### LITHOGRAPHIC STONE IMPORTED INTO THE UNITED STATES FROM 1868 TO 1889, INCLUSIVE.

| Years ended— | |
|---|---|
| June 30, 1868 | $13,258 |
| 1869 | 17,044 |
| 1870 | 14,225 |
| 1871 | 21,311 |
| 1872 | 36,146 |
| 1873 | 44,937 |
| 1874 | 36,902 |
| 1875 | 41,963 |
| 1876 | 47,101 |
| 1877 | 44,503 |
| 1878 | 42,709 |
| June 30, 1879 | $37,746 |
| 1880 | 56,310 |
| 1881 | 77,894 |
| 1882 | 111,925 |
| 1883 | 104,313 |
| 1884 | 128,035 |
| 1885 | 54,022 |
| 1886 | 71,009 |
| Dec. 31, 1887 | 83,182 |
| 1888 | 113,365 |
| 1889 | 78,077 |

# SULPHUR.

# SULPHUR.

BY E. W. PARKER.

## PRODUCING LOCALITIES IN 1889.

Although deposits of sulphur are reported to have been discovered in a number of places throughout the United States, in only 4 states have there been developments of any commercial importance, and in but 2 of these, Utah and Nevada, was there any production in 1889. In Nevada work was just begun during the year, the beds being located near the town of Winnemucca, and said to be very valuable. The mine producing sulphur in 1889 in Utah is located about 12 miles south of the town of Frisco. The total output of these 2 mines was 1,150 short tons of ore, producing 450 tons of sulphur, valued at $7,850, as shown in the following table:

PRODUCTION OF SULPHUR FOR 1889.

[Short tons.]

| STATES AND TERRITORIES. | Amount of ore produced. | Refined sulphur. | Value. |
|---|---|---|---|
| Nevada | 550 | 250 | $3,850 |
| Utah | *a*600 | 200 | 4,000 |

*a* Estimated.

The following tables include the men employed at both places above and below ground, the wages paid per day, the number of days employed, the expenses incurred in operating the mines, and the amount of capital invested:

LABOR EMPLOYED.

| EMPLOYÉS. | Average number employed. | Average wages per day. | Average number of days worked. |
|---|---|---|---|
| Total | 12 | | |
| Foremen | 2 | $4.50 | 80 |
| Miners | 7 | 3.00 | 77 |
| Boys under 16 years of age | 3 | 0.50 | 60 |

OPERATING EXPENSES.

| | |
|---|---|
| Paid for wages | $2,410 |
| Paid for supplies | 1,700 |
| Total | 4,110 |

CAPITAL INVESTED.

| | |
|---|---|
| In land | *a*$312,500 |
| In buildings, machinery, etc | 2,750 |
| In tools, implements, live stock, etc | 5,500 |
| Total | 320,750 |

*a* Includes valuation of Louisiana property.

## PREVIOUS OPERATIONS AND PRODUCTION.

Prior to 1889 sulphur deposits of notable value had been located in California, Louisiana, and Utah. In California it has been found in about 10 counties, but with the exception of the deposit at Clear Lake, Lake county, no work has been done. In 1864 a refinery, with a capacity of 6 tons per day, was erected at this place, and until 1868 was engaged in the refining of sulphur, but owing to a drop of about 50 per cent in the price of refined sulphur at San Francisco the enterprise ceased to be profitable and was abandoned.

It is stated that the Mormons refined sulphur from native ore as early as 1850. About the year 1870 considerable prospecting was done in the neighborhood of Cove creek, and during the next 2 years several claims were located, and a few have been developed. The Dickert & Myers Sulphur Company, organized in 1883, was engaged up to 1888 in operating the deposits in the vicinity of Cove creek.

The sulphur beds of Louisiana are located about 12 miles from Lake Charles and 80 miles west of New Orleans. The discovery of the sulphur-bearing stratum was the result of explorations after petroleum, which, from surface indications, it was thought could be found in profitable quantity. In this the prospectors were disappointed, but their disappointment was in a measure offset by the discovery, at the depth of 443 feet, of a stratum of sulphur, said to be of exceptional purity. A company was formed for the purpose of developing the property, and a shaft was sunk to the depth of 150 feet, when an accident stopped the work. Up to 1889 no further work had been done, but in that year the property changed hands, and the present owner expects to commence operations shortly.

## IMPORTS.

The amount of sulphur produced in the United States is small, indeed, compared to that imported into the country. This is due largely to the excessive cost of transportation from the western mines, it being possible to put down Sicilian sulphur in New York at a lower figure than it would cost to transport the product of Utah or Nevada. The following table shows the imports of sulphur for the years 1867 to 1889, inclusive:

SULPHUR IMPORTED INTO THE UNITED STATES FROM 1867 TO 1889, INCLUSIVE.

[Long tons.]

| YEARS ENDED— | CRUDE. | | "FLOWERS" OF SULPHUR. | | REFINED. | | Ore. (a) | Total value. |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | | |
| June 30, 1867 | 24,544 | $620,373 | 110 | $5,509 | 251 | $10,915 | .......... | $636,797 |
| 1868 | 18,151 | 446,547 | 16 | 948 | 65 | 2,721 | .......... | 450,216 |
| 1869 | 23,590 | 678,642 | 97 | 4,576 | 645 | 27,149 | .......... | 710,367 |
| 1870 | 27,380 | 819,408 | 76 | 3,927 | 157 | 6,528 | $1,269 | 831,132 |
| 1871 | 36,131 | 1,212,448 | [illegible] | 3,514 | 92 | 4,328 | 754 | 1,221,044 |
| 1872 | 25,380 | 764,798 | 36 | 1,822 | 57 | 2,492 | .......... | 769,112 |
| 1873 | 45,533 | 1,301,000 | 55 | 2,924 | 36 | 1,497 | .......... | 1,305,421 |
| 1874 | 40,990 | 1,260,491 | 51 | 2,694 | 57 | 2,403 | .......... | 1,265,588 |
| 1875 | 39,683 | 1,259,472 | 18 | 891 | .......... | .......... | .......... | 1,260,363 |
| 1876 | 46,435 | 1,475,250 | 41 | 2,114 | 44 | 1,927 | .......... | 1,479,291 |
| 1877 | 42,963 | 1,242,888 | 116 | 5,873 | 1,171 | 36,962 | .......... | 1,285,723 |
| 1878 | 48,102 | 1,179,769 | 159 | 7,628 | 150 | 5,935 | .......... | 1,193,332 |
| 1879 | 70,370 | 1,575,533 | 138 | 6,509 | 69 | 2,392 | .......... | 1,584,434 |
| 1880 | 87,837 | 2,024,121 | 124 | 5,516 | 158 | 5,262 | .......... | 2,034,899 |
| 1881 | 105,097 | 2,713,485 | 98 | 4,226 | 71 | 2,555 | .......... | 2,720,266 |
| 1882 | 97,504 | 2,627,402 | 159 | 6,926 | 59 | 2,196 | .......... | 2,636,524 |
| 1883 | 94,540 | 2,288,946 | 79 | 3,262 | 115 | 4,487 | .......... | 2,296,695 |
| 1884 | 105,112 | 2,242,697 | 178 | 7,869 | 126 | 4,765 | .......... | 2,255,331 |
| 1885 | 96,839 | 1,941,943 | 121 | 5,351 | 114 | 4,060 | .......... | 1,951,354 |
| 1886 | 117,538 | 2,237,989 | 213 | 8,739 | 116 | 3,877 | .......... | 2,250,605 |
| 1887 | 96,882 | 1,688,360 | 279 | 9,980 | 84 | 2,383 | .......... | 1,700,723 |
| Dec. 31, 1888 | 120,104 | 1,927,336 | 60 | 1,921 | .......... | 3 | .......... | 1,929,260 |
| 1889 | 135,935 | 2,068,208 | 282 | 8,184 | 10 | 299 | .......... | 2,076,691 |

a Since 1871 classed under the head of pyrites.

## PRINCIPAL SOURCES OF SUPPLY.

Italy and the island of Sicily furnish the larger part of the world's supply of sulphur, 90 per cent coming from Sicily. The sulphur-producing districts of Sicily cover about one-third of the entire island, and include nearly all of the provinces of Girjenti and Caltanisetta. A few mines are also found in the provinces of Palermo and Catania. Some sulphur is produced at Hakodadi, in Japan, most of which is shipped to San Francisco. The trade in Japanese sulphur is limited on account of poor facilities for mining and shipping. The ore is said to be of good quality, yielding 50 per cent of sulphur. The sulphur mines of Sicily, on the other hand, while not possessing the richness of ore claimed for the Japanese, are conveniently situated for shipping the product and labor is exceedingly cheap. These advantages will continue to make the island the chief source of supply for some years to come. It is reported that large fields of sulphur on the island of Saba, one of the Lesser Antilles group of the West Indies, have been purchased by a syndicate composed of Boston and Lowell capitalists, and though the mines are said to be some distance inland, and the cost of mining and transportation to the seaboard will be quite heavy, this expense is warranted by the quantity and purity of the ore.

In a report under date of August 20, 1889, Mr. Vincent Lamantia, United States consul at Catania, island of Sicily, gives some interesting information regarding the sulphur mines of Sicily, from which the following data are abstracted. There are in all 567 mines on the island, 376 of which were in operation at the time of writing his report. Some of the important mines give employment to as many as 400 men and boys. The wages for men amounts to about 58 cents per day, and for boys about 29 cents, 8 hours being the usual length of a working day. The amount of sulphur exported from the island of Sicily for the years 1850 to 1888, inclusive, and the countries receiving the same are shown in the following tables:

SULPHUR EXPORTED FROM SICILY TO VARIOUS COUNTRIES FROM 1850 TO 1888, INCLUSIVE.

[Short tons.]

| YEARS. | Total. | Italy. | Great Britain. | France. | United States. | Other countries. |
|---|---|---|---|---|---|---|
| Total | 3, 303, 948 | 478, 884 | 744, 237 | 729, 555 | 596, 724 | 754, 548 |
| 1850 | 21, 426 | 843 | 7, 170 | 9, 456 | 1, 818 | 2, 139 |
| 1851 | 25, 932 | 1, 188 | 10, 419 | 9, 273 | 1, 695 | 3, 357 |
| 1852 | 26, 094 | 1, 743 | 7, 353 | 11, 688 | 1, 668 | 3, 642 |
| 1853 | 30, 972 | 174 | 15, 483 | 10, 287 | 1, 173 | 3, 855 |
| 1854 | 38, 214 | 1, 131 | 21, 429 | 8, 253 | 2, 211 | 5, 190 |
| 1855 | 33, 747 | 1, 221 | 16, 176 | 12, 276 | 678 | 3, 396 |
| 1856 | 39, 894 | 855 | 17, 889 | 14, 787 | 1, 338 | 5, 025 |
| 1857 | 39, 621 | 897 | 16, 662 | 18, 858 | 738 | 2, 466 |
| 1858 | 37, 227 | 2, 628 | 17, 928 | 11, 322 | 969 | 4, 380 |
| 1859 | 49, 260 | 2, 334 | 20, 301 | 18, 597 | 3, 468 | 4, 560 |
| 1860 | 39, 975 | 2, 691 | 16, 809 | 13, 074 | 2, 229 | 5, 172 |
| 1861 | 44, 973 | 3, 918 | 16, 446 | 18, 090 | 603 | 5, 916 |
| 1862 | 63, 693 | 5, 757 | 23, 424 | 18, 561 | 4, 326 | 11, 625 |
| 1863 | 75, 477 | 14, 511 | 17, 358 | 22, 986 | 3, 132 | 17, 490 |
| 1864 | 69, 429 | 11, 754 | 23, 403 | 21, 051 | 2, 379 | 10, 842 |
| 1865 | 70, 152 | 14, 454 | 20, 256 | 16, 755 | 5, 682 | 13, 005 |
| 1866 | 70, 965 | 7, 245 | 27, 777 | 16, 746 | 5, 688 | 13, 509 |
| 1867 | 78, 261 | 11, 040 | 23, 439 | 17, 940 | 4, 245 | 21, 597 |
| 1868 | 73, 344 | 12, 132 | 22, 485 | 18, 096 | 5, 859 | 14, 772 |
| 1869 | 73, 107 | 11, 766 | 23, 115 | 14, 943 | 8, 034 | 15, 249 |
| 1870 | 78, 144 | 11, 124 | 27, 282 | 12, 603 | 9, 627 | 17, 508 |
| 1871 | 80, 601 | 11, 844 | 24, 588 | 14, 898 | 10, 227 | 19, 044 |
| 1872 | 91, 653 | 14, 487 | 23, 502 | 22, 071 | 9, 654 | 21, 939 |
| 1873 | 99, 672 | 17, 046 | 18, 693 | 21, 672 | 10, 362 | 31, 899 |
| 1874 | 85, 746 | 15, 081 | 19, 935 | 13, 467 | 10, 461 | 26, 802 |
| 1875 | 101, 868 | 15, 075 | 24, 177 | 14, 655 | 9, 555 | 38, 406 |
| 1876 | 92, 436 | 14, 430 | 19, 509 | 12, 162 | 8, 943 | 37, 392 |
| 1877 | 98, 847 | 21, 504 | 21, 342 | 16, 041 | 16, 773 | 23, 187 |
| 1878 | 109, 203 | 22, 887 | 17, 001 | 20, 286 | 24, 633 | 24, 396 |
| 1879 | 132, 411 | 24, 036 | 19, 833 | 31, 563 | 32, 697 | 24, 282 |
| 1880 | 136, 869 | 12, 960 | 19, 338 | 31, 779 | 47, 166 | 25, 626 |
| 1881 | 133, 251 | 14, 019 | 21, 033 | 28, 425 | 42, 720 | 27, 054 |
| 1882 | 136, 746 | 19, 584 | 18, 840 | 21, 294 | 43, 263 | 33, 765 |
| 1883 | 150, 297 | 33, 072 | 19, 578 | 30, 186 | 36, 510 | 30, 951 |
| 1884 | 148, 353 | 27, 903 | 18, 774 | 30, 684 | 41, 829 | 29, 163 |
| 1885 | 148, 860 | 23, 925 | 17, 025 | 26, 235 | 34, 947 | 46, 728 |
| 1886 | 159, 087 | 25, 152 | 15, 444 | 26, 001 | 46, 188 | 46, 302 |
| 1887 | 150, 168 | 23, 580 | 15, 438 | 27, 003 | 42, 273 | 41, 874 |
| 1888 | 167, 973 | 22, 893 | 17, 583 | 25, 491 | 60, 963 | 41, 043 |

SULPHUR EXPORTED FROM SICILY IN 1889.

[Short tons.]

| EXPORTED TO— | Total. | From Girjenti. | From Catania. | From Licata. |
|---|---|---|---|---|
| Total | 171, 105 | 71, 838 | 55, 659 | 43, 608 |
| United States | 53, 250 | 35, 436 | 6, 201 | 11, 613 |
| France | 32, 619 | 15, 810 | 3, 855 | 12, 954 |
| Italy | 21, 171 | 2, 367 | 14, 994 | 3, 810 |
| Great Britain | 18, 276 | 7, 995 | 9, 597 | 684 |
| Other countries | 45, 789 | 10, 230 | 21, 012 | 14, 547 |
| Total in 1888 | 167, 973 | 69, 276 | 60, 267 | 38, 430 |

SULPHUR EXPORTS FROM SICILY FOR 10 YEARS, FROM 1879 TO 1888, INCLUSIVE.

| | SHORT TONS. |
|---|---|
| Girjenti | 644, 543 |
| Catania | 555, 410 |
| Licata | 264, 062 |
| Total | 1, 464, 015 |

## COUNTRIES IMPORTING SICILIAN SULPHUR FROM 1879 TO 1888, INCLUSIVE.

| | SHORT TONS. |
|---|---|
| United States | 428, 556 |
| France | 278, 661 |
| Italy | 227, 124 |
| Great Britain | 182, 886 |
| Other countries | 346, 788 |
| Total | 1, 464, 015 |

## STATEMENT, BY COUNTRIES AND BY CUSTOMS DISTRICTS, SHOWING THE IMPORTS INTO THE UNITED STATES OF CRUDE SULPHUR OR BRIMSTONE EACH FISCAL YEAR FROM 1876 TO 1889, INCLUSIVE.

[Short tons.]

| COUNTRIES WHENCE EXPORTED AND CUSTOMS DISTRICTS THROUGH WHICH IMPORTED. | 1876. | | 1877. | | 1878. | | 1879. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| COUNTRIES | 48, 966 | $1, 473, 678 | 43, 443 | $1, 242, 788 | 47, 922 | $1, 173, 156 | 65, 919 | $1, 487, 698 |
| Dutch West Indies and Guiana | 1, 515 | 15, 427 | | | | | | |
| England | 30 | 1, 211 | 425 | 14, 631 | (?) | 16 | 2 | 335 |
| Scotland | 24 | 910 | 472 | 13, 231 | 160 | 3, 961 | 806 | 19, 287 |
| Gibraltar | | | 290 | 7, 789 | | | | |
| Quebec, Ontario, Manitoba, etc | | | | | 12 | 264 | | |
| Italy | 46, 941 | 1, 439, 839 | 41, 819 | 1, 194, 000 | 47, 494 | 1, 161, 367 | 64, 420 | 1, 453, 138 |
| Japan | 456 | 16, 291 | 437 | 13, 137 | 256 | 7, 548 | 224 | 4, 528 |
| Portugal | | | | | | | 467 | 10, 410 |
| DISTRICTS | 48, 966 | 1, 473, 678 | 43, 443 | 1, 242, 788 | 47, 922 | 1, 173, 156 | 65, 919 | 1, 487, 698 |
| Baltimore, Maryland | 5, 157 | 157, 828 | 3, 882 | 105, 175 | 5, 455 | 138, 202 | 6, 969 | 157, 243 |
| Barnstable, Massachusetts | | | | | | | 600 | 13, 780 |
| Boston and Charlestown, Massachusetts | 5, 031 | 154, 883 | 3, 931 | 101, 215 | 5, 795 | 131, 945 | 7, 841 | 173, 506 |
| Charleston, South Carolina | | | | | 526 | 12, 267 | 605 | 13, 812 |
| Delaware, Delaware | 450 | 13, 500 | | | | | 890 | 21, 907 |
| Huron, Michigan | | | | | 12 | 264 | | |
| Newark, New Jersey | | | 1, 071 | 31, 802 | 462 | 13, 240 | 443 | 10, 175 |
| New Orleans, Louisiana | 172 | 5, 705 | 150 | 4, 750 | | | 100 | 2, 087 |
| New York, New York | 24, 524 | 721, 092 | 21, 867 | 654, 997 | 28, 240 | 690, 989 | 36, 543 | 827, 193 |
| Philadelphia, Pennsylvania | 12, 549 | 385, 071 | 9, 216 | 256, 224 | 6, 657 | 167, 222 | 11, 704 | 263, 467 |
| Providence, Rhode Island | 600 | 18, 232 | 1, 739 | 45, 487 | 519 | 11, 479 | | |
| San Francisco, California | 483 | 17, 367 | 862 | 27, 768 | 256 | 7, 548 | 224 | 4, 528 |
| Savannah, Georgia | | | 725 | 15, 370 | | | | |

| COUNTRIES WHENCE EXPORTED AND CUSTOMS DISTRICTS THROUGH WHICH IMPORTED. | 1880. | | 1881. | | 1882. | | 1883. | |
|---|---|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| COUNTRIES | 83, 236 | $1, 927, 502 | 105, 438 | $2, 713, 494 | 97, 956 | $2, 627, 402 | 94, 536 | $2, 288, 795 |
| England | 1 | 22 | | | | | 13 | 379 |
| Scotland | 1, 664 | 36, 444 | 1, 668 | 43, 311 | 755 | 20, 294 | 3 | 88 |
| France | 988 | 23, 580 | | | 526 | 13, 770 | 34 | 858 |
| French West Indies | | | | | 2 | 8 | | |
| Greece | | | | | 500 | 13, 927 | | |
| Italy | 80, 301 | 1, 862, 712 | 102, 771 | 2, 645, 293 | 92, 944 | 2, 504, 862 | 92, 861 | 2, 248, 870 |
| Japan | 282 | 4, 744 | 691 | 16, 253 | 2, 980 | 66, 356 | 1, 038 | 23, 714 |
| San Domingo | | | | | 240 | 7, 875 | | |
| Spain | | | 308 | 8, 637 | | | 500 | 12, 856 |
| Spanish possessions in Africa and adjacent islands. | | | | | 9 | 310 | 87 | 2, 030 |
| DISTRICTS | 83, 236 | 1, 927, 502 | 105, 438 | 2, 713, 494 | 97, 956 | 2, 627, 402 | 94, 536 | 2, 288, 795 |
| Baltimore, Maryland | 13, 827 | 313, 342 | 16, 477 | 430, 917 | 13, 781 | 364, 384 | 11, 977 | 286, 438 |
| Beaufort, South Carolina | | | | | 540 | 13, 889 | | |
| Boston and Charlestown, Massachusetts | 8, 207 | 183, 486 | 8, 860 | 226, 801 | 7, 467 | 194, 317 | 7, 756 | 173, 569 |
| Charleston, South Carolina | 1, 061 | 25, 398 | 3, 065 | 78, 741 | 6, 025 | 161, 281 | 4, 051 | 106, 235 |
| Middletown, Connecticut | | | | | 9 | 310 | | |
| New Orleans, Louisiana | 280 | 7, 121 | 100 | 2, 646 | 220 | 6, 516 | 428 | 10, 378 |
| New York, New York | 46, 657 | 1, 083, 784 | 57, 608 | 1, 463, 082 | 46, 531 | 1, 260, 222 | 45, 385 | 1, 110, 313 |
| Philadelphia, Pennsylvania | 10, 679 | 254, 892 | 17, 987 | 477, 547 | 14, 839 | 408, 611 | 22, 772 | 549, 095 |
| Providence, Rhode Island | 1, 255 | 31, 155 | 650 | 17, 507 | 1, 244 | 33, 036 | 535 | 13, 830 |
| Richmond, Virginia | | | | | 660 | 17, 760 | | |
| San Francisco, California | 1, 270 | 28, 324 | 691 | 16, 253 | 6, 054 | 151, 234 | 1, 072 | 24, 572 |
| Savannah, Georgia | | | | | 586 | 15, 842 | 560 | 14, 365 |

STATEMENT, BY COUNTRIES AND BY CUSTOMS DISTRICTS, SHOWING THE IMPORTS, ETC.—Continued.

[Short tons.]

| COUNTRIES WHENCE EXPORTED AND CUSTOMS DISTRICTS THROUGH WHICH IMPORTED. | 1884. (a) | | 1885. | | 1886. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| COUNTRIES | 105, 143 | $2, 242, 678 | 96, 841 | $1, 941, 943 | 117, 396 | $2, 237, 332 |
| Belgium | | | 190 | 4, 766 | 60 | 1, 718 |
| England | | | 606 | 15, 084 | 81 | 2, 535 |
| Quebec, Ontario, Manitoba, and the Northwest Territory | | | | | | 9 |
| Italy | | | 94, 370 | 1, 894, 858 | 112, 283 | 2, 166, 565 |
| Japan | | | 1, 541 | 25, 683 | 4, 972 | 66, 505 |
| Spain | | | 134 | 1, 552 | | |
| DISTRICTS | 105, 143 | 2, 242, 678 | 96, 841 | 1, 941, 943 | 117, 396 | 2, 237, 332 |
| Baltimore, Maryland | 15, 037 | 303, 226 | 14, 505 | 285, 006 | 19, 307 | 364, 958 |
| Barnstable, Massachusetts | 650 | 16, 163 | 480 | 11, 040 | 1, 617 | 35, 385 |
| Beaufort, South Carolina | 600 | 13, 259 | 610 | 12, 847 | | |
| Boston and Charlestown, Massachusetts | 5, 294 | 112, 152 | 5, 125 | 99, 712 | 3, 681 | 69, 898 |
| Champlain, New York | | | | | | 9 |
| Charleston, South Carolina | 6, 125 | 132, 570 | 8, 525 | 169, 564 | 13, 350 | 265, 265 |
| New Orleans, Louisiana | | | 102 | 2, 282 | 250 | 5, 102 |
| New York, New York | 52, 478 | 1, 135, 725 | 45, 537 | 909, 123 | 58, 758 | 1, 115, 519 |
| Philadelphia, Pennsylvania | 18, 786 | 401, 468 | 18, 696 | 381, 010 | 15, 568 | 300, 749 |
| Providence, Rhode Island | 651 | 15, 517 | 1, 840 | 37, 422 | 1, 265 | 25, 930 |
| San Francisco, California | 5, 522 | 112, 598 | 1, 421 | 33, 937 | 3, 600 | 54, 517 |

| COUNTRIES WHENCE EXPORTED AND CUSTOMS DISTRICTS THROUGH WHICH IMPORTED. | 1887. | | 1888. | | 1889. | |
|---|---|---|---|---|---|---|
| | Quantity. | Value. | Quantity. | Value. | Quantity. | Value. |
| COUNTRIES | 97, 383 | $1, 688, 360 | 99, 253 | $1, 581, 582 | 130, 191 | $2, 025, 644 |
| Belgium | | | 83 | 1, 933 | 180 | 4, 086 |
| Danish West Indies | 861 | 5, 250 | | | | |
| England | 162 | 4, 437 | 310 | 7, 200 | 305 | 8, 337 |
| France | 290 | 6, 951 | | | | |
| Italy | 89, 924 | 1, 588, 146 | 92, 528 | 1, 499, 720 | 123, 260 | 1, 935, 368 |
| Japan | 6, 146 | 83, 576 | 6, 332 | 72, 729 | 6, 446 | 77, 853 |
| DISTRICTS | 97, 383 | 1, 688, 360 | 99, 253 | 1, 581, 582 | 130, 191 | 2, 025, 644 |
| Baltimore, Maryland | 12, 547 | 225, 669 | 11, 989 | 182, 769 | 15, 791 | 234, 693 |
| Barnstable, Massachusetts | 1, 152 | 22, 816 | | | | |
| Beaufort, South Carolina | | | 500 | 9, 000 | 600 | 9, 213 |
| Boston and Charlestown, Massachusetts | 4, 850 | 85, 575 | 3, 760 | 62, 298 | 6, 446 | 104, 257 |
| Charleston, South Carolina | 12, 420 | 220, 598 | 12, 005 | 199, 048 | 23, 377 | 364, 859 |
| New Orleans, Louisiana | | | 200 | 3, 845 | | |
| New York, New York | 46, 711 | 792, 114 | 50, 486 | 816, 286 | 60, 922 | 959, 872 |
| Philadelphia, Pennsylvania | 15, 267 | 269, 216 | 10, 519 | 173, 699 | 13, 288 | 202, 357 |
| Providence, Rhode Island | 600 | 11, 291 | 1, 310 | 21, 012 | 570 | 8, 581 |
| San Francisco, California | 3, 176 | 50, 521 | 6, 352 | 78, 732 | 4, 539 | 57, 925 |
| Savannah, Georgia | | | | | 2, 345 | 44, 244 |
| Wilmington, North Carolina | | | 1, 532 | 25, 893 | 1, 753 | 28, 443 |
| All other customs districts | 660 | 10, 560 | 600 | 9, 000 | 560 | 11, 200 |

*a* Sources not reported.

## PRICES.

The price for crude sulphur from 1881 to 1887 showed a steady decline. From $31 per ton for seconds in 1881 it fell to $27.50 at the close of 1882, to $27 in 1883, $23.50 in 1884, $22.40 in 1885, until in 1887 it reached as low as $19.50 for seconds and $19.25 for thirds. The price has continued to range between $19.25 and $21 since that year for seconds and $18 to $19.25 for thirds. The prices at the opening of 1889 were $19.25 and $19.50 for seconds and $18.75 to $19 for thirds. In December the price for seconds was from $19 to $19.50, and for thirds from $18.25 to $18.75. The decline in prices is attributed to the increasing consumption of pyrites for the manufacture of sulphuric acid.

## THE CHANCE PROCESS.

Another source of supply in 1889 was the sulphur recovered from alkali works by the Chance process, which converts the sulphur of the waste calcium sulphide into hydrogen sulphide and from this to free sulphur. Some 20 or more alkali works in England have adopted this process, and the resulting sulphur is shipped largely to the United States. The economic value of this discovery is twofold: (1) The foul odors which poisoned the atmosphere in the vicinity of the alkali works and the pollution of running streams are corrected. (2) All of the sulphur used in the process of alkali manufacture goes into this waste. Its recovery by this process means an annual saving of from 180,000 to 200,000 tons. The problem whose solution ,brings the above result occupied the time and labor of Mr. William Gossage for 30 years. He accomplished a partial success, which was perfected by Mr. A. M. Chance, of Oldbury, England, after 6 years of study. The process, briefly, is as follows: the waste (calcium sulphide), mixed with water, is placed in vessels connected by pipes, and carbonic-acid gas from limekilns is pumped through them. If any free lime be present the carbonic acid immediately combines with it to form calcium carbonate. It also combines in the presence of water with the calcium sulphide, forming calcium carbonate and hydrogen sulphide. Other gases, chiefly nitrogen, are eliminated during the process. The next object is to obtain the sulphur from the hydrogen sulphide. This is effected by the process patented by C. F. Claus by means of what is known as the Claus kiln. The hydrogen sulphide, with proper proportions of air, is passed over anhydrous oxide of iron. The sulphur is liberated while the oxide of iron is kept at a dull red heat by the reaction.

# PYRITES.

# PYRITES.

BY E. W. PARKER.

## PRODUCTION.

The pyrites treated under this report includes only that mined for its sulphur contents and used in the manufacture of sulphuric acid. Pyrites occurs more or less plentifully in almost every state of the Union, but its production during 1889 was limited to 3 states, Massachusetts, New Hampshire, and Virginia. Owing to large stocks on hand and the prevalence of low prices, the New Hampshire mines, located at Copperville, Coos county, were not operated during the calendar year 1889. The product from Massachusetts and Virginia, labor employed at mines, operating expenses, and capital invested are shown in the following tables:

### PRODUCTION OF PYRITES IN 1889.

[Short tons.]

| STATES. | Quantity. | Value. |
|---|---|---|
| Total | 104,950 | $202,119 |
| Massachusetts | 36,350 | 92,119 |
| Virginia | 68,600 | 110,000 |

### LABOR EMPLOYED AT PYRITES MINES.

| STATES. | ABOVE GROUND. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | | Average wages per day. | | | | Average number of days worked. | | | |
| | Foremen. | Mechanics. | Laborers. | Boys under 16 years. | Foremen. | Mechanics. | Laborers. | Boys under 16 years. | Foremen. | Mechanics. | Laborers. | Boys under 16 years. |
| Total | 4 | 17 | 65 | 22 | $1.75 | $1.59 | $1.06 | $0.53 | 287 | 291 | 273 | 235 |
| Massachusetts | 1 | 5 | 20 | 3 | 2.00 | 2.21 | 1.25 | 0.75 | 300 | 290 | 276 | 276 |
| Virginia | 3 | 12 | 45 | 19 | 1.66 | 1.33 | 0.97 | 0.50 | 283 | 292 | 272 | 229 |

| STATES. | BELOW GROUND. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Average number employed. | | | Average wages per day. | | | Average number of days worked. | | |
| | Foremen. | Miners. | Laborers. | Foremen. | Miners. | Laborers. | Foremen. | Miners. | Laborers. |
| Total | 3 | 75 | 51 | $3.13 | $1.55 | $1.27 | 303 | 185 | 254 |
| Massachusetts | 1 | 25 | 16 | 3.40 | 2.00 | 1.80 | 308 | 288 | 288 |
| Virginia | 2 | 50 | 35 | 3.00 | 1.33 | 1.03 | 300 | 133 | 239 |

### OPERATING EXPENSES.

| STATES. | Total expenditures. | Wages. | Office force at mines. | Paid contractors. | Paid for supplies. | Other expenditures. |
|---|---|---|---|---|---|---|
| Total | $163,256 | $62,379 | $5,512 | $23,103 | $42,000 | $30,262 |
| Massachusetts | 63,156 | 10,379 | 2,412 | 23,103 | 17,000 | 10,262 |
| Virginia | 100,100 | 52,000 | 3,100 | .......... | 25,000 | 20,000 |

CAPITAL INVESTED.

| STATES. | Total. | In land. | Buildings, machinery, etc. | Tools, implements, live stock, etc. | Cash. |
|---|---|---|---|---|---|
| Total | $1,358,882 | $955,500 | $207,000 | $149,504 | $46,878 |
| Massachusetts | 258,882 | 165,500 | 47,000 | 44,504 | 1,878 |
| Virginia | 1,100,000 | 790,000 | 160,000 | 105,000 | 45,000 |

## SULPHURIC ACID FROM PYRITES.

Considering the liberal manner in which pyrites is distributed throughout the United States and the economy with which sulphuric acid may be prepared from it, it is remarkable that the production of pyrites for this purpose continues comparatively small. For all ordinary purposes, such as the refining of petroleum, the manufacture of fertilizers known as superphosphates, the washing of wool, etc., acid from pyrites serves equally well with that made from brimstone, though for medicinal purposes pyrites acid is objectionable, owing to the fact that it is apt to contain arsenic or other injurious impurities in the ore. The principal reasons for the objection to the use of pyrites given by manufacturers of acid are, first, the changes necessary in the furnaces for roasting the ore, the pyrites requiring to be burned over a grate, and, second, the remoteness of the mines from manufacturing centers and the cost of transportation. A great deal of attention is now being paid to pyrites localities in the country, particularly those in the southern states, and it is to be expected that as these properties are further developed suitable furnaces for the manufacture of acid will be erected at the mines and the trade supplied direct. By this means the cost of transporting the ore will be overcome, and, as experiments have shown that a ton of acid can be more economically prepared from pyrites than from imported brimstone, a decided increase in production may be looked for in the near future. Mr. W. H. Adams, of Mineral City, Virginia, has made the following estimates on the comparative cost of sulphuric acid made from brimstone (imported) and pyrites (computations are made for plants at Atlanta, Georgia):

COST OF SULPHURIC ACID FROM BRIMSTONE AT ATLANTA, GEORGIA.

(One day's work.)

| | |
|---|---|
| 4 tons of brimstone, including cost of freight, losses in transit, etc., at $24 per ton | $96.00 |
| Nitrate of soda, 6 per cent of brimstone used, 538 pounds, at $2.50 per 100 pounds | 13.45 |
| Labor, 5 men, at $1.25 per day | 6.25 |
| Coal, 2 tons, at $3 per ton | 6.00 |
| Superintendent and office cost | 6.00 |
| Wear and tear | 10.00 |
| Producing 18 tons of chamber acid ($7.65 per ton) | 137.70 |

COST OF SULPHURIC ACID FROM PYRITES AT ATLANTA, GEORGIA.

(One day's work.)

| | |
|---|---|
| 10 tons pyrites, including costs as above, at $5 per ton | $50.00 |
| Nitrate of soda, 400 pounds, at $2.50 per 100 pounds | 10.00 |
| Coal | 6.00 |
| Labor | 6.25 |
| Superintendent and office cost | 6.00 |
| Wear and tear | 10.00 |
| Producing 18 tons of chamber acid ($4.90 per ton) | 88.25 |

This would seem to be a decided advantage in favor of using pyrites. The advantage of making acid at the mines would appear still more apparent. The cost of mining pyrites and laying it down ready for shipment has been estimated at $1.50 per ton. The production of 104,950 tons of pyrites during the year 1889, at a total cost of $163,256, makes the cost per ton $1.56, showing the estimate to be very near correct. The cost of pyrites in the preceding comparative table is placed at $5 per ton, leaving a difference of $3.44 per ton in favor of manufacture at the mines. These figures would, however, be partly offset by probable additional cost of labor and greater cost of coal and other supplies at points distant from trade centers.

In a contribution to Mineral Resources of the United States for 1886 Mr. Richard P. Rothwell gives the following comparative statements of the cost of producing sulphuric acid from brimstone and pyrites in the districts of New York and Philadelphia:

COMPARATIVE COST OF PRODUCING 1 TON OF SULPHURIC ACID FROM BRIMSTONE AND PYRITES.

| BRIMSTONE. | Cost per ton. | PYRITES. | Cost per ton. |
|---|---|---|---|
| Total | $30.60 | Total | $25.75 |
| 1 ton (2,000 pounds) of brimstone "thirds", 98 per cent sulphur | 19.00 | 2.5 short tons of iron pyrites, 46 per cent sulphur, at 10 cents per unit per ton. | 11.50 |
| 50 pounds nitrate of soda, at 2.5 cents per pound | 1.25 | 60 pounds nitrate of soda, at 2.5 cents per pound | 1.50 |
| 5 hundredweight coal, $4 per ton | 1.00 | 5 hundredweight coal, at, say, $4 per ton | 1.00 |
| Workmen's wages | 2.25 | Workmen's wages | 3.00 |
| Superintendence and management | 2.00 | Superintendence and management | 2.00 |
| General jobbing repairs | 0.50 | General jobbing repairs | 0.60 |
| Interest on capital of $75,000 (*a*) | 4.60 | Interest on capital of $100,000 (*a*) | 6.15 |
| Product 4.5 tons of 50° baumé, cost per ton | 6.80 | Product 4.5 tons of 50° baumé, cost per ton | 5.72 |

*a* At 10 per cent per annum, the works being calculated to last only 10 years and to produce during that time 20 tons of acid daily.

## SAVING TO BE ACCOMPLISHED IN USING PYRITES.

Aside from the evident economy which the manufacture of acid from pyrites involves for the manufacturer, a saving to the country is to be noted in the amount paid for sulphur to owners of foreign mines. The 104,950 tons of pyrites produced in 1889 replace about 40,000 tons of imported brimstone, or, in other words, exert an annual saving to the country of about $800,000 in cash. Assuming that this quantity of pyrites will produce 180,000 tons of sulphuric acid, it will be seen that there is still a very large demand to be filled. It is estimated that there are about 1,000,000 tons of this acid consumed annually in this country, and its use is constantly increasing and new fields opening. With such a prospect there is no reason to fear that the increased production of pyrites will have any appreciable effect on prices of sulphuric acid.

## PRODUCTION IN PREVIOUS YEARS.

The following table shows the production of domestic pyrites from 1882 to 1889, inclusive:

PRODUCTION OF PYRITES IN THE UNITED STATES FROM 1882 TO 1889, INCLUSIVE.

[Long tons.]

| YEARS. | Quantity. | Value. |
|---|---|---|
| 1882 | 12,000 | $72,000 |
| 1883 | 25,000 | 137,500 |
| 1884 | 35,000 | 175,000 |
| 1885 | 49,000 | 220,500 |
| 1886 | 55,000 | 220,000 |
| 1887 | 52,000 | 210,000 |
| 1888 | 54,331 | 167,658 |
| 1889 | *a*104,950 | 202,119 |

*a* Short tons.

IMPORTS OF PYRITES CONTAINING NOT MORE THAN 3.5 PER CENT COPPER. (*a*)

[Long tons.]

| YEARS. | Quantity. | Value. |
|---|---|---|
| 1884 | 16,710 | $50,632 |
| 1885 | 6,078 | 18,577 |
| 1886 | 1,605 | 9,771 |
| 1887 | 16,578 | 49,661 |

*a* Previous to 1884 classed among sulphur ores; subsequent to 1887 classed among other iron ores.

# MINERAL WATERS.

# MINERAL WATERS.

BY ALBERT C. PEALE.

## PRODUCTION.

The total value of the production of mineral waters in the United States for the year 1889 was $1,748,458. The total number of gallons sold was 12,780,471, being the production of 258 springs.

No comparison can be made with any previous census returns, as they do not exist, nor can a comparison be made with any state returns of previous years. The accompanying table is the first in which the production has ever been given by states and territories.

In a table on page 781 a comparison is made with the production by geographical divisions from 1883 to 1888, as published in Mineral Resources of the United States. According to this table there was a total increase in 1889 of 3,951,823 gallons over the production of 1888. The increase in value is $189,156. This value, of course, takes no account of the estimate made in 1888 of the springs not reporting, as no account has been taken of the springs delinquent for 1889. The number of springs from which the water is used commercially has increased from a total of 198 in 1888 to 258 in 1889.

In the North Atlantic states there is an increase of 1,249,665 gallons. A decrease of 1,043,148 gallons is reported from the South Atlantic states, while in the North Central states the increase in production for 1889 is 4,135,403 gallons. The South Central states show an increase of 73,590 gallons, and the Western states and territories a decrease of 463,687 gallons.

PRODUCTION OF MINERAL WATERS FOR 1889, BY STATES AND TERRITORIES.

| STATES AND TERRITORIES. | Number of springs reporting. | Product. (Gallons.) | Value of product. | Capital invested. | Wages. | Supplies and materials consumed. | All other expenses. |
|---|---|---|---|---|---|---|---|
| Total | 258 | 12, 780, 471 | $1, 748, 458 | $5, 994, 683 | $433, 583 | $524, 864 | $210, 304 |
| Alabama | 5 | 24, 380 | 2, 430 | 17, 550 | 760 | 325 | 140 |
| Arkansas | 3 | 110, 200 | 10, 020 | 12, 525 | 3, 690 | 1, 525 | 300 |
| California | 14 | 808, 625 | 252, 241 | 590, 062 | 93, 991 | 11, 649 | 3, 326 |
| Colorado | 8 | 304, 600 | 87, 400 | 261, 311 | 25, 180 | 51, 990 | 525 |
| Connecticut | 3 | 4, 410 | 2, 630 | 8, 000 | 978 | 1, 000 | ........... |
| Georgia | 3 | 31, 120 | 9, 412 | 69, 260 | 1, 112 | 500 | 250 |
| Illinois | 10 | 2, 207, 216 | 38, 697 | 39, 210 | 7, 637 | 10, 488 | 7, 632 |
| Indiana | 8 | 125, 162 | 9, 525 | 62, 200 | 3, 030 | 800 | 170 |
| Iowa | 5 | 12, 780 | 2, 490 | 15, 000 | 2, 700 | 50 | 1, 165 |
| Kansas | 9 | 245, 033 | 15, 394 | 148, 400 | 9, 218 | 3, 850 | 380 |
| Kentucky | 5 | 121, 350 | 14, 378 | 54, 000 | 7, 700 | 600 | 1, 000 |
| Maine | 8 | 888, 600 | 79, 060 | 169, 335 | 41, 464 | 23, 796 | 6, 473 |
| Maryland | 4 | 74, 160 | 12, 057 | 95, 403 | 4, 758 | 9, 584 | 9, 392 |
| Massachusetts | 8 | 1, 011, 173 | 63, 622 | 94, 416 | 16, 663 | 21, 758 | 6, 106 |
| Michigan | 7 | 333, 345 | 67, 987 | 135, 800 | 5, 778 | 29, 900 | 6, 690 |
| Mississippi | 2 | 8, 870 | 1, 174 | 5, 000 | 500 | ........... | 50 |
| Missouri and Nebraska | 14 | 289, 720 | 23, 270 | 152, 395 | 4, 923 | 1, 954 | 1, 394 |
| New Hampshire | 2 | 60, 000 | 4, 500 | 13, 000 | 1, 100 | 300 | ........... |
| New Mexico | 4 | 32, 700 | 10, 225 | 92, 525 | 5, 050 | 1, 400 | 500 |
| New York | 21 | 1, 795, 543 | 239, 875 | 1, 850, 250 | 59, 232 | 54, 065 | 50, 112 |
| North Carolina | 11 | 70, 644 | 19, 431 | 66, 950 | 6, 599 | 1, 637 | 3, 382 |
| Ohio | 11 | 251, 610 | 26, 696 | 75, 890 | 4, 637 | 3, 825 | 950 |
| Oregon | 2 | 4, 800 | 1, 680 | 102, 750 | 600 | ........... | 250 |
| Pennsylvania | 12 | 275, 700 | 65, 163 | 670, 300 | 18, 147 | 13, 650 | 8, 050 |
| Rhode Island | 2 | 47, 000 | 2, 975 | 11, 400 | 1, 095 | 525 | 100 |
| South Carolina | 2 | 50, 520 | 10, 046 | 41, 500 | 1, 310 | 1, 000 | 2, 000 |
| Tennessee | 4 | 21, 500 | 5, 000 | 20, 200 | 1, 460 | 50 | 200 |
| Texas | 14 | 213, 700 | 10, 354 | 66, 440 | 6, 473 | 2, 465 | 302 |
| Vermont | 3 | 16, 150 | 11, 975 | 8, 000 | 650 | 275 | 200 |
| Virginia | 22 | 397, 395 | 141, 476 | 215, 450 | 15, 028 | 41, 900 | 20, 295 |
| Washington | 3 | 113, 748 | 14, 943 | 33, 200 | 4, 921 | 4, 300 | 895 |
| West Virginia | 4 | 21, 900 | 5, 360 | 11, 000 | 1, 225 | 275 | 700 |
| Wisconsin | 20 | 2, 292, 910 | 409, 179 | 681, 500 | 61, 930 | 198, 821 | 70, 700 |
| Other states (a) | 5 | 513, 907 | 77, 793 | 104, 461 | 14, 044 | 30, 607 | 6, 575 |

a Florida, Idaho, Minnesota, New Jersey, and South Dakota.

## IMPORTS.

Prior to 1884 the Treasury department did not distinguish natural mineral waters from those that were artificial. Since 1883 the distinction has been made, but the artificial waters have not been classified according to the receptacles in which they have been imported. The importation is shown in the 2 tables following, with a table of exports appended.

### MINERAL WATERS IMPORTED INTO THE UNITED STATES FROM 1867 TO 1883, INCLUSIVE.

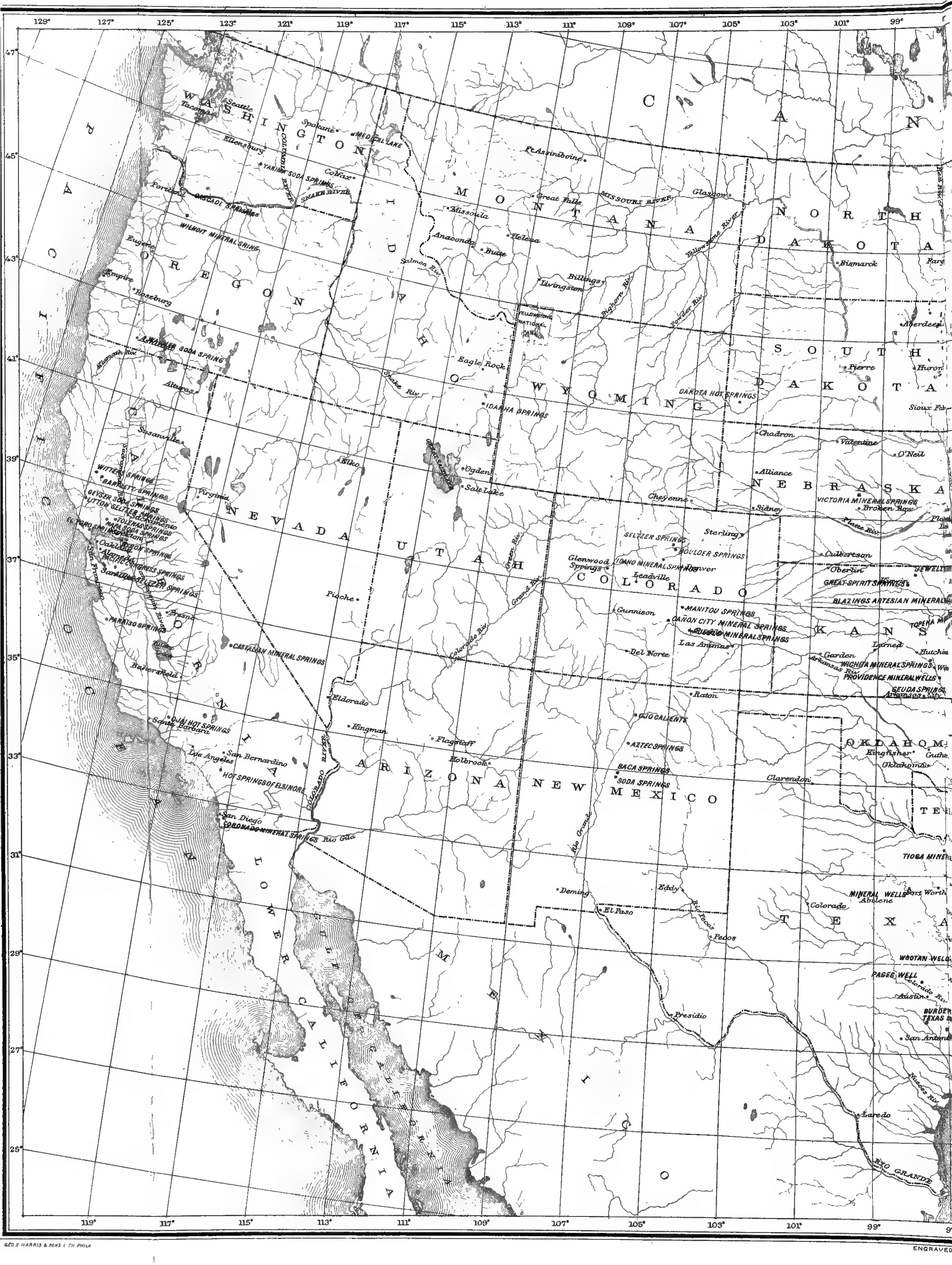
| YEARS ENDED— | Total. | IN BOTTLES OF ONE QUART OR LESS. | | IN BOTTLES IN EXCESS OF ONE QUART. | | NOT IN BOTTLES. | | ALL, NOT ARTIFICIAL. | |
|---|---|---|---|---|---|---|---|---|---|
| | | Quantity. (Bottles.) | Value. | Quantity. (Quarts.) | Value. | Quantity. (Gallons.) | Value. | Quantity. (Gallons.) | Value. |
| June 30, 1867 | $25, 410 | 370, 610 | $24, 913 | 3, 792 | $360 | | $137 | | |
| 1868 | 20, 594 | 241, 702 | 18, 438 | 22, 819 | 2, 052 | 554 | 104 | | |
| 1869 | 26, 682 | 344, 691 | 25, 635 | 9, 739 | 802 | 1; 042 | 245 | | |
| 1870 | 32, 931 | 433, 212 | 30, 680 | 18, 025 | 1, 743 | 2, 063 | 508 | | |
| 1871 | 34, 919 | 470, 947 | 34, 604 | 2, 320 | 174 | 1, 336 | 141 | | |
| 1872 | 68, 067 | 892, 913 | 67, 951 | | | 639 | 116 | | |
| 1873 | 100, 552 | 35, 508 | 2, 326 | | | 355 | 75 | 394, 423 | $98, 151 |
| 1874 | 80. 496 | 7, 238 | 691 | | | 95 | 16 | 199, 035 | 79, 789 |
| 1875 | 102, 113 | 4, 174 | 471 | | | 5 | 2 | 395, 956 | 101, 640 |
| 1876 | 136, 788 | 25, 758 | 1, 899 | | | | | 447, 646 | 134, 889 |
| 1877 | 168, 808 | 12, 965 | 1, 328 | | | | 22 | 520, 751 | 167, 458 |
| 1878 | 351, 727 | 8, 229 | 815 | | | | | 883, 674 | 350, 912 |
| 1879 | 284, 509 | 28, 440 | 2, 352 | | | 3 | 4 | 798, 107 | 282, 153 |
| 1880 | 305, 529 | 207, 554 | 19, 731 | | | | | 927, 759 | 285, 798 |
| 1881 | 395, 492 | 150, 326 | 11, 850 | | | 55 | 26 | 1, 225, 462 | 383, 616 |
| 1882 | 427, 115 | 152, 277 | 17, 010 | | | | | 1, 542, 905 | 410, 105 |
| 1883 | 448, 493 | 88, 497 | 7, 054 | | | | | 1, 714, 085 | 441, 439 |

### IMPORTS FOR THE YEARS 1884 TO 1888, INCLUSIVE.

| YEARS ENDED— | ARTIFICIAL MINERAL WATERS. | | NATURAL MINERAL WATERS. | |
|---|---|---|---|---|
| | Gallons. | Value. | Gallons. | Value. |
| June 30, 1884 | 29, 366 | $4, 591 | 1, 505, 298 | $362, 651 |
| 1885 | 7, 972 | 2, 157 | 1, 660, 072 | 397, 875 |
| Dec. 31, 1886 | 62, 464 | 16, 815 | 1, 618, 960 | 354, 242 |
| 1887 | 13, 885 | 4, 851 | 1, 915, 511 | 385, 906 |
| 1888 | 12, 752 | 4, 411 | 1, 716, 461 | 341, 695 |

### VALUE OF EXPORTS OF NATURAL MINERAL WATERS FROM THE UNITED STATES.

| Years ended June 30— | | Years ended June 30— | |
|---|---|---|---|
| 1875 | $162 | 1881 | $1, 029 |
| 1876 | 80 | 1882 | 421 |
| 1879 | 1, 529 | 1883 | 459 |
| 1880 | 1, 486 | 1884, 1885, 1886, 1887, and 1888 | None. |



GEO. S. HARRIS & SONS LITH PHILA

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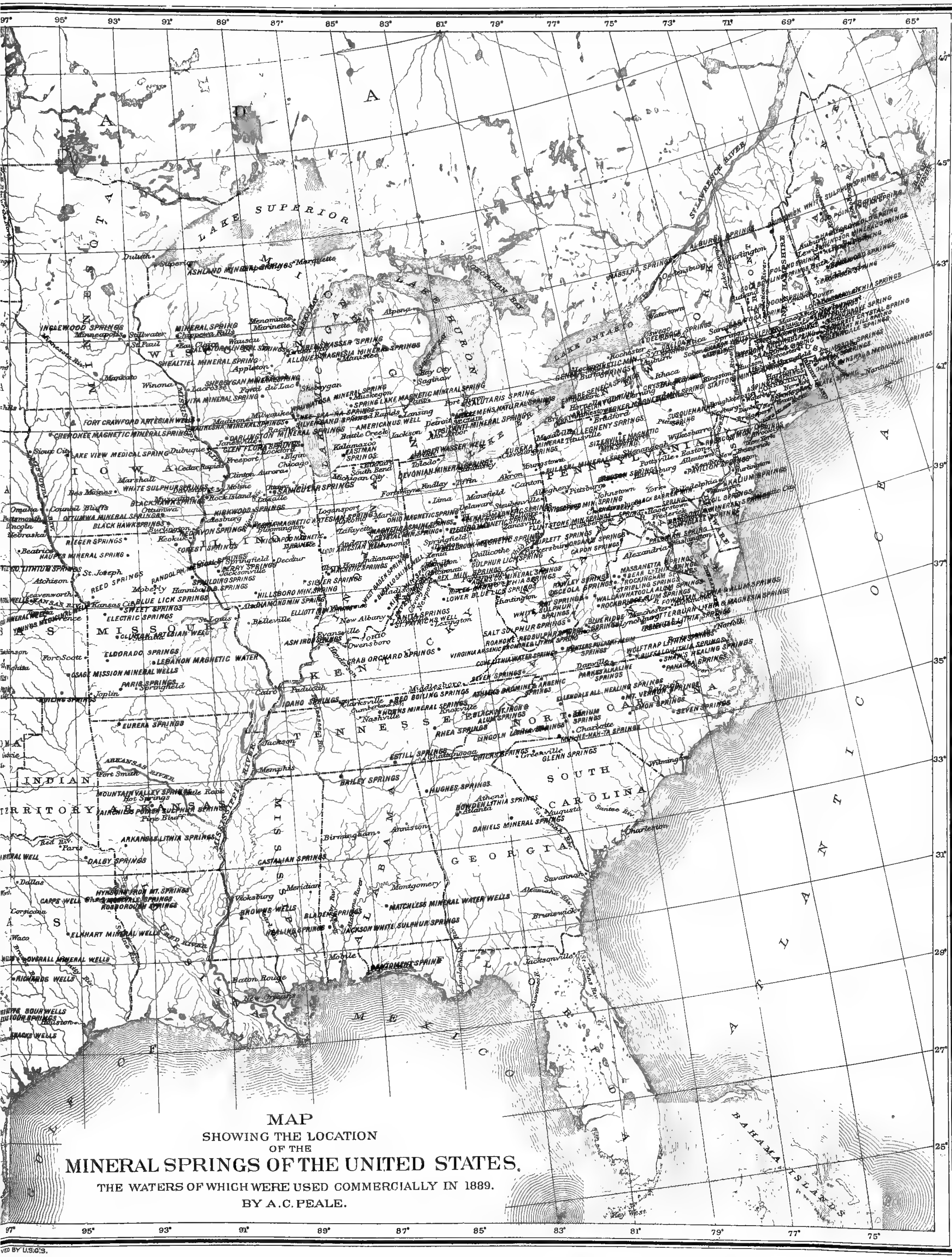

# MAP

SHOWING THE LOCATION

OF THE

# MINERAL SPRINGS OF THE UNITED STATES.

THE WATERS OF WHICH WERE USED COMMERCIALLY IN 1889.

BY A.C. PEALE.

VED BY U.S.G.S.

PRODUCTION BY GEOGRAPHICAL DIVISIONS OF NATURAL MINERAL WATERS SOLD FROM 1883 TO 1888, INCLUSIVE.

| GEOGRAPHICAL DIVISIONS. | Springs reporting. | Gallons sold. | Value. | GEOGRAPHICAL DIVISIONS. | Springs reporting. | Gallons sold. | Value. |
|---|---|---|---|---|---|---|---|
| 1883. | | | | 1886. | | | |
| North Atlantic | 38 | 2,470,670 | $282,270 | North Atlantic | 49 | 2,715,050 | $177,969 |
| South Atlantic | 27 | 312,090 | 64,973 | South Atlantic | 38 | 720,397 | 123,517 |
| North Central | 37 | 1,435,809 | 323,600 | North Central | 40 | 2,048,914 | 401,861 |
| South Central | 21 | 1,441,042 | 139,973 | South Central | 31 | 822,016 | 58,222 |
| Western | 6 | 169,812 | 52,787 | Western | 14 | 781,540 | 137,796 |
| | 129 | 5,829,423 | 863,603 | | 172 | 7,087,917 | 899,365 |
| Estimated | 60 | 1,700,000 | 256,000 | Estimated | 53 | 1,862,400 | 384,705 |
| Total | 189 | 7,529,423 | 1,119,603 | Total | 225 | 8,950,317 | 1,284,070 |
| 1884. | | | | 1887. | | | |
| North Atlantic | 38 | 3,345,760 | 328,125 | North Atlantic | 40 | 2,571,004 | 213,210 |
| South Atlantic | 27 | 464,718 | 103,191 | South Atlantic | 34 | 614,041 | 147,149 |
| North Central | 37 | 2,070,533 | 420,515 | North Central | 38 | 1,480,820 | 208,217 |
| South Central | 21 | 1,526,817 | 147,112 | South Central | 29 | 741,080 | 87,946 |
| Western | 6 | 307,500 | 85,200 | Western | 12 | 1,236,324 | 288,737 |
| | 129 | 7,715,328 | 1,084,143 | | 153 | 6,643,269 | 945,259 |
| Estimated | 60 | 2,500,000 | 375,000 | Estimated | 62 | 1,616,340 | 316,204 |
| Total | 189 | 10,215,328 | 1,459,143 | Total | 215 | 8,259,609 | 1,261,463 |
| 1885. | | | | 1888. | | | |
| North Atlantic | 51 | 2,527,310 | 192,605 | North Atlantic | 42 | 2,856,799 | 247,108 |
| South Atlantic | 32 | 908,692 | 237,153 | South Atlantic | 32 | 1,689,387 | 493,489 |
| North Central | 45 | 2,925,288 | 446,211 | North Central | 38 | 2,002,373 | 325,839 |
| South Central | 31 | 540,436 | 74,100 | South Central | 19 | 426,410 | 71,215 |
| Western | 10 | 509,675 | 86,776 | Western | 15 | 1,853,679 | 421,651 |
| | 169 | 7,411,401 | 1,036,845 | | 146 | 8,828,648 | 1,559,302 |
| Estimated | 55 | 1,737,000 | 276,000 | Estimated | 52 | 750,000 | 120,000 |
| Total | 224 | 9,148,401 | 1,312,845 | Total | 198 | 9,578,648 | 1,679,302 |

PRODUCTION OF NATURAL MINERAL WATERS SOLD IN 1889.

| GEOGRAPHICAL DIVISIONS. | Springs reporting. | Gallons sold. | Value. |
|---|---|---|---|
| Total | 258 | 12,780,471 | $1,748,458 |
| North Atlantic | 60 | 4,106,464 | 471,575 |
| South Atlantic | 47 | 646,239 | 198,032 |
| North Central | 86 | 6,137,776 | 604,238 |
| South Central | 33 | 500,000 | 43,356 |
| Western | 32 | 1,389,992 | 431,257 |

## GEOGRAPHICAL DISTRIBUTION.

The accompanying map shows the location of those springs in the United States the waters of which are used commercially. It will be observed that the waters put upon the market are more numerous from the eastern half of the country. This is not because there are more springs in that section, but mainly because the greatest proportion of population is found there, and, consequently, it is more thoroughly developed as to the utilization of its resources.

The following table shows the rank of the various states according to the number of springs and production in each state:

RANK OF VARIOUS STATES ACCORDING TO NUMBER AND PRODUCTION OF SPRINGS.

| STATES AND TERRITORIES. | Rank according to number of springs. | Rank according to production. | STATES AND TERRITORIES. | Rank according to number of springs. | Rank according to production. | STATES AND TERRITORIES. | Rank according to number of springs. | Rank according to production. |
|---|---|---|---|---|---|---|---|---|
| Alabama | No. 12 | No. 28 | Maine | No. 10 | No. 5 | Ohio | No. 7 | No. 13 |
| Arkansas | No. 14 | No. 20 | Maryland | No. 13 | No. 21 | Oregon | No. 15 | No. 36 |
| California | No. 4 | No. 6 | Massachusetts | No. 10 | No. 4 | Pennsylvania | No. 6 | No. 12 |
| Colorado | No. 10 | No. 10 | Michigan | No. 11 | No. 9 | Rhode Island | No. 15 | No. 25 |
| Connecticut | No. 14 | No. 37 | Minnesota | No. 16 | No. 8 | South Carolina | No. 15 | No. 24 |
| Florida | No. 16 | No. 38 | Mississippi | No. 15 | No. 34 | South Dakota | No. 16 | No. 33 |
| Georgia | No. 14 | No. 27 | Missouri | No. 5 | No. 11 | Tennessee | No. 13 | No. 30 |
| Idaho | No. 16 | No. 16 | Nebraska | No. 16 |  | Texas | No. 4 | No. 15 |
| Illinois | No. 8 | No. 2 | New Hampshire | No. 15 | No. 23 | Vermont | No. 14 | No. 31 |
| Indiana | No. 10 | No. 17 | New Jersey | No. 16 | No. 35 | Virginia | No. 1 | No. 7 |
| Iowa | No. 12 | No. 32 | New Mexico | No. 13 | No. 26 | Washington | No. 14 | No. 19 |
| Kansas | No. 9 | No. 14 | New York | No. 2 | No. 3 | West Virginia | No. 13 | No. 29 |
| Kentucky | No. 12 | No. 18 | North Carolina | No. 7 | No. 22 | Wisconsin | No. 3 | No. 1 |

Inasmuch as mineral waters derive their solid contents from the rocks through which they pass on their way to the surface, when they appear as springs, there is an intimate connection between them and the geological structure of the country in which they are found, and a comparison of the map on which the springs are plotted with a geological map of the same region is very instructive. In regions where the older or metamorphic rocks form the surface, or are near to it, the waters as a rule contain a smaller proportion of solid ingredients than where they have to pass through strata that are more readily affected by their solvent powers, thus giving an explanation of the differences between the waters of various sections of the country. The connection of warm and hot springs with mountain elevations and fractures and dislocations of the strata and with areas in which eruptive rocks prevail has frequently been noted, and it is therefore not surprising to find this group of springs so largely in excess of cold springs in the western part of the United States, where large areas covered by flows of basaltic and trachytic rocks prevail.

## CLASSIFICATION.

In the first place, all waters are characterized by their temperature, as cold, tepid, warm, or hot. They are therefore divisible into 2 great groups, nonthermal and thermal.

The term thermal is not used here as applying to springs whose temperature is above the mean annual temperature of the place in which they are located, but included under this designation are those springs the waters of which have a temperature of 70° fahrenheit or more. A thermal spring may belong to any one of the classes or divisions which are based on the predominating solid constituents.

The fact that a spring is thermal depends mainly upon its geological position. Warm and hot springs are found in regions of volcanic rocks, in connection with faulted or dislocated strata, in areas of mountain corrugation, or where borings have been made to great depths below the surface. It has frequently been stated that thermal springs are less highly mineralized than others, but facts do not sustain this statement. They are less numerous, but there appears to be no reason why they may not duplicate nonthermal springs in every particular except temperature. Each group of waters is next divided into 4 classes, viz, alkaline, alkaline-saline, saline, and acid.

The term "indifferent" or "chemically indifferent" of many schemes of classification has not been used. The question as to whether a water should be called indifferent is one upon which it would be difficult to secure unanimous opinion. The spring owner would perhaps draw his line at one place, the physician who prescribes the water might draw it at another, and the chemist at still a third place.

The analyses should therefore be arranged in order according to the proportion of the classifying ingredient, beginning with the least highly mineralized water under each division, and it seems preferable that the lines of indifference be drawn by those especially interested. Pure water is a production of the chemical laboratory alone. No chalybeate waters are placed on a line with alkaline or saline waters. Of course, all iron waters are tonic in their effects, but they may differ widely in other properties. When the various analyses of chalybeate springs are compared, it is found that those in which iron exists as a carbonate contain also carbonates of the alkalies or alkaline earths. Others contain iron sulphates with various other sulphates, or they may be characterized by chlorides. Others again have free acid with the saline constituents. The chalybeates therefore, it seems, should be subdivisions of the alkaline, alkaline-saline, saline, and acid classes, and here they are placed in this scheme. The fact that they all contain iron should not relegate them to one class, especially when their effects may be widely different. The other ingredients must not be ignored.

Almost the same remarks hold good for the sulphur springs that have been made in regard to the chalybeate springs. Sulphur springs are those in which free sulphureted hydrogen exists; that is, they have a gaseous constituent. A very little sulphureted hydrogen will go a great way in classifying a spring, but there is no more reason to disregard the solid constituents here than in the case of the chalybeates. Even the chalybeates may be sulphureted, and in fact any division of the 4 classes outlined may contain the same gaseous constituent.

The waters are therefore characterized finally according to the gas they contain. They may be nongaseous, carbonated, sulphureted, carbureted, or azotized (that is, containing nitrogen gas).

It may be objected that the sulphur springs are separated one from the other; but if necessary the scheme can be reversed and the gaseous character indicated first. If this be done, the alkaline, saline, and acid springs must be divided up and separated. The plan adopted here is more compact. It seems preferable to keep all the alkaline waters, etc., together, particularly as the analyses are not nearly so complete with reference to the gaseous constituents as they are in regard to the solid constituents. Many waters lose the gases long before the water is analyzed in the laboratory, and therefore frequently no account is taken of them beyond the mention of their existence.

In nearly all lithia waters the amount of lithia is relatively small, and very often consists only of traces, so that the springs are classified by some other ingredient. However, the fact that the water contains lithia, even if only a trace, will probably be expressed in the name given to the spring. In making these remarks, of course, nothing is said as to the efficacy or nonefficacy of even the traces in some of the waters. What is true of the lithia waters is true of many others which are supposed to be particularly efficacious in certain diseases. In no scheme of classification can account be taken of all the minor constituents. It is impossible to express all the shades of difference, and in the examination of the analyses with a view to the use of the water a process of exclusion or elimination will have to be followed in order to get the water just suited to the peculiar conditions presented.

Returning now to the scheme outlined, the first class is alkaline. This name has been so long and universally used to include those waters that contain the alkaline carbonates that it is retained. Included under it are all waters characterized by carbonates, whether of the alkalies, alkaline earths, alkaline metals, or even of iron alone, for as already noted, the carbonate of iron is usually associated with alkaline carbonates. The alkaline waters as thus designated are divided primarily into five great divisions, viz, sodic, potassic, calcic, magnesic, and chalybeate, in which the carbonates of sodium, potassium, calcium, magnesium, and iron, respectively, predominate. Those springs are also separated in which there is a combination, as calcic-chalybeate, sodic-magnesic, etc., and they may also have a combination of two or more of the gases, as sulphocarbonated, etc.

Some few springs contain a large quantity of free nitrogen gas. These are designated as azotized. In others the predominating gas is carbureted hydrogen; that is, they are carbureted. For those springs characterized by free carbonic-acid gas the term carbonated instead of acidulous is used to avoid confusion with acid springs. There are carbonated acid sulphated springs, that is, springs with free sulphuric acid, sulphates, and free carbonic-acid gas; and to call these springs acidulous acid springs would be, to say the least, somewhat awkward.

Nearly one-half of the alkaline springs are calcic-alkaline; that is, with calcium carbonate or bicarbonate predominating. The calcic-chalybeate springs come next in number. A great many of the well-known springs fall under the head of calcic-alkaline, such as the Waukesha springs of Wisconsin, the Poland spring of Maine, the Hot springs of Virginia, etc. The lists following give the springs arranged according to total solid contents.

The next class includes the alkaline-saline springs, viz, those in which there is a mixture of carbonates with sulphates or chlorides. It is separated, therefore, into two divisions, sulphated and muriated, according to the predominance of either set of salts, and, secondly, subdivided exactly as were the alkaline springs, according to the base, into the sodic, potassic, magnesic, chalybeate, etc. Each one of these subdivisions may also be nongaseous, carbonated, or sulphureted, etc. The most prominent springs under the head of alkaline-saline are the Saratoga springs, which are placed under the head of carbonated sodic-muriated alkaline-saline springs, that is, they contain free carbonic-acid gas and have sodium chloride predominating, and contain also alkaline carbonates. Naturally the sodic-muriated springs are the most numerous in this class.

The third class, saline springs, is divided exactly as are the alkaline-saline springs. The salines outnumber the alkaline-salines in the proportion of three to one, and are nearly one-third more numerous than the alkaline springs. Almost all of the springs usually classed under the head of purgative or aperient saline will fall under the head of sulphated salines in this scheme.

Thus a sodic-sulphated water and a magnesic-sulphated water would not be mistaken for anything else than purgative waters. Among other waters of this division are many springs well-known all over the country.

About one-quarter of all the sulphated salines in the country are calcic. Possibly in arranging these waters the proportion of the other sulphates ought also to be given, as the calcic-sulphate is supposed to be inert medicinally. Sharon springs, New York, would be placed under the head of sulphureted calcic-magnesic sulphated waters, and some of the Richfield springs belong there also. Possibly they should be called sulphocarbonated, although the sulphureted hydrogen largely predominates. A large number of the alum springs fall under the chalybeate-sulphated springs. Those with free sulphuric acid, however, belong to the acid class.

Of the muriated saline springs nearly 88 per cent are sodic-muriated; that is, with common salt as the principal constituent. Of course, all brines fall under this head.

The fourth and last class is named acid, a class that has been neglected in most schemes of classification. Here under the sulphated-acid division are placed those waters characterized by the presence of free sulphuric acid and sulphates. They include the sour springs found at many localities in Texas, the Oak Orchard acid springs of New York, the Blossburg springs of Pennsylvania, the Iowa acid springs, and most of the alum springs of Virginia and Kentucky, those of Virginia being most numerously found in the markets. The muriated-acid springs are those characterized by the presence of free hydrochloric acid in connection with chlorides.

The foregoing remarks apply to the mineral springs of the country as a whole, and in the following attempt to classify the commercial natural mineral waters of the United States in accordance with the scheme outlined, only the springs actually reporting sales are included.

SCHEME OF CLASSIFICATION OF NATURAL MINERAL WATERS.

GROUP A.—NONTHERMAL. GROUP B.—THERMAL.

| | | |
|---|---|---|
| Class I. | Alkaline. | |
| Class II. | Alkaline-saline | 1. Sulphated.<br>2. Muriated. |
| Class III. | Saline | 1. Sulphated.<br>2. Muriated. |
| Class IV. | Acid | 1. Sulphated.<br>2. Muriated.<br>3. Siliceous { a Sulphated. b Muriated. |

The commercial waters following are not noted as belonging to either Group A or Group B, as when placed upon the market they are practically nonthermal, whether they are considered as thermal or nonthermal at the spring furnishing the water.

Many of the springs in this list would be indicated in some systems of classification as "indifferent", but the line of indifference is one that would be drawn at very different places by different persons, according to their points of view. Therefore, the total solid contents of the waters are given and each one interested can draw the line.

## I. ALKALINE SPRINGS.

| | GRAINS PER GALLON. |
|---|---|
| SODIC: | |
| Pavilion springs, Pennsylvania | 1.98 |
| Medical lake, Washington | 101.46 |
| CARBONATED SODIC: | |
| Corry artesian fountain, Pennsylvania | 20.59 |
| Bladen springs, Alabama | 48.88 |
| Geyser Soda spring, California | 57.12 |
| El Toro spring, California | 187.15 |
| Litton Seltzer spring, California | 228.69 |
| Joseph's Ojo Caliente springs, New Mexico | 1,686.34 |
| SULPHURETED SODIC: | |
| Allegheny Sulphur springs, Pennsylvania | 24.20 |
| SODIC-CALCIC: | |
| Ashley's Bromine and Arsenic spring, Tennessee | 4.82 |
| CARBONATED SODIC-CALCIC: | |
| Navajo spring, Manitou Springs, Colorado | 25.33 |
| Ute spring, Manitou Springs, Colorado | 97.49 |
| SODIC-CHALYBEATE: | |
| Cold Bowling spring, Maine | 1.60 |
| Bailey springs, Alabama | 14.88 |
| CARBONATED SODIC-CHALYBEATE: | |
| Panacea springs, North Carolina | 9.79 |
| Iron Ute springs, Manitou, Colorado | 210.87 |
| CALCIC-ALKALINE: | |
| Undine spring, Massachusetts | 0.27 |
| Arcadian Mineral spring, Waukesha, Wisconsin | 0.36 |
| Mineral Rock spring, Waukesha, Wisconsin | 0.38 |
| Sheep Rock spring, Massachusetts | 0.81 |
| Old Point Indian spring, Maine | 2.80 |
| Pæonian spring, Virginia | 3.57 |
| Belmont Natural spring, Massachusetts | 3.69 |
| Poland spring, Maine | 3.75 |
| All Healing spring, North Carolina | 7.31 |
| Chattolanee spring, Maryland | 8.29 |

| CALCIC-ALKALINE—Continued. | GRAINS PER GALLON. |
|---|---|
| Echo Grove Mineral spring, Massachusetts | 8.41 |
| Ochee spring, Rhode Island | 8.99 |
| Lincoln Lithia spring, North Carolina | 10.65 |
| Inglewood spring, Minnesota | 16.56 |
| Horeb Mineral springs, Waukesha, Wisconsin | 20.02 |
| Bellbrook Magnetic spring, Massachusetts | 26.79 |
| Mountain Valley spring, Arkansas | 21.82 |
| Lake View Medical spring, Iowa | 32.28 |
| Clysmic spring, Waukesha, Wisconsin | 35.46 |
| Hygeia spring, Waukesha, Wisconsin | 36.21 |
| Glen Flora Mineral spring, Illinois | 36.41 |
| Bethesda spring, Waukesha, Wisconsin | 35.71 |
| White Rock Mineral spring, Waukesha, Wisconsin | 37.06 |
| Kickapoo Magnetic springs, Indiana | 41.91 |
| Lenape Magnetic spring, Ohio | 55.70 |
| Electric Magnetic springs, Ohio | 61.33 |
| CARBONATED CALCIC: | |
| Hot springs, Virginia | 0.60 |
| Roscommon spring, Pennsylvania | 1.21 |
| Sweet spring, Bedford Springs, Pennsylvania | 1.62 |
| Aztec springs, New Mexico | 2.83 |
| Crystal springs, Yates county, New York | 12.08 |
| Capon springs, West Virginia | 12.15 |
| Large Limestone spring, Bedford Springs, Pennsylvania | 14.70 |
| Manitou spring, Manitou Springs, Colorado | 18.20 |
| Wolf Trap Lithia springs, Virginia | 19.83 |
| Massanetta Mineral spring, Virginia | 25.76 |
| Electric springs, Missouri | 41.73 |
| Bartlett springs, California | 43.35 |
| SULPHOCARBONATED CALCIC: | |
| Roanoke Red Sulphur springs, Virginia | 5.21 |
| Spring No. 2 (sulphur spring), Stribling Springs, Virginia | 34.88 |

| | GRAINS PER GALLON. |
|---|---|
| Calcic-magnesic: | |
| Shealtiel Mineral springs, Wisconsin | 14.65 |
| Henk Mineral spring, Waukesha, Wisconsin | 14.65 |
| Nee-Ska-Ra spring, Wisconsin | 29.59 |
| Lebens Wasser spring, Wisconsin | 31.22 |
| Darlington Mineral spring, Wisconsin | 31.79 |
| Salvador Mineral spring, Wisconsin | 33.03 |
| Alma spring, Waukesha, Wisconsin | 33.35 |
| Vita Mineral spring, Wisconsin | 34.06 |
| Perry springs, Illinois | 38.24 |
| Ashland spring, Wisconsin | 43.69 |
| Allouez Magnesia Mineral spring, Wisconsin | 62.38 |
| Carbonated calcic-magnesic: | |
| Bear Lithia springs, Virginia | 9.60 |
| Otterburn Lithia and Magnesic spring, Virginia | 9.86 |
| Lebanon Magnetic spring, Missouri | 10.72 |
| Eastman springs, Michigan | 18.04 |
| Osceola Lithia spring, Virginia | 34.39 |
| Ohio Magnetic springs, Ohio | 44.90 |
| Idanha spring, Idaho | 152.14 |
| Sulphocarbonated calcic-magnesic: | |
| Cove Lithia spring, Virginia | 10.61 |
| Calcic-chalybeate: | |
| Shaw's Healing springs, North Carolina | 8.40 |
| Park's Alkaline spring, North Carolina | 14.93 |
| Carbonated calcic-chalybeate: | |
| Chalybeate springs, Stribling Springs, Virginia | 20.95 |
| Reed's Mineral springs, Missouri | 26.38 |
| Carbonated magnesic: | |
| Susquehanna spring, Pennsylvania | 9.92 |
| Farmville Lithia springs, Virginia | 26.39 |
| Napa Soda springs, California | 68.76 |
| Wagner Soda spring, Oregon | 163.87 |
| Magnesic chalybeate: | |
| Keystone spring, Maine | 3.00 |
| Windsor Chalybeate spring, Maine | 5.60 |
| Carbonated chalybeate: | |
| Maine fountain, Rawley springs, Virginia | 5.78 |
| Cherokee Magnetic Mineral spring, Iowa | 29.93 |
| Sulphocarbonated chalybeate: | |
| Chalybeate spring, Eureka Mineral Springs, Pennsylvania | 42.35 |

## II. ALKALINE-SALINE SPRINGS.

### 1. Sulphated.

| | |
|---|---|
| Carbonated sodic: | |
| Ponemah springs, New Hampshire | 3.03 |
| Sodic-magnesic: | |
| Idaho Hot springs, Colorado | 177.69 |
| Calcic: | |
| Allandale spring, Massachusetts | 3.30 |
| Carbonated calcic: | |
| William's spring, Paris Chalybeate Springs, Missouri | 1.10 |
| Hartfort Cold spring, Maine | 44.68 |
| Spring No. 2, Buffalo Lithia Springs, Virginia | 98.38 |
| Shoshone spring, Manitou Springs, Colorado | 132.80 |
| Little Chief spring, Manitou Springs, Colorado | 132.80 |
| Calcic-sodic chalybeate: | |
| Topeka Mineral wells, Kansas | 147.45 |
| Calcic-magnesic: | |
| Virginia Arsenic Bromine and Lithia spring, Virginia | 18.37 |
| Victoria Mineral springs, Nebraska | 62.18 |
| Sulphureted calcic-magnesic: | |
| Sharon springs, New York: | |
| Gardner Magnesia spring | 127.64 |
| Magnesia spring | 132.70 |
| White Sulphur spring | 149.10 |
| Sulphocarbonated calcic-magnesic chalybeate: | |
| Kirkwood Mineral spring, Illinois | 22.28 |
| Carbonated calcic-chalybeate: | |
| Spring No. 3, Buffalo Lithia spring, Virginia | 14.47 |

### 2. Muriated.

| | GRAINS. PER GALLON. |
|---|---|
| Sodic: | |
| Underwood spring, Maine | 2.10 |
| Bowden Lithia spring, Georgia: | |
| Bromine Lithia spring | 173.37 |
| Bowden Lithia spring | 191.10 |
| Iron Duke, Cañon City Springs, Colorado | 219.54 |
| Little Ute, Cañon City Springs, Colorado | 242.95 |
| Castalian mineral water, California | 4,422.25 |
| Carbonated sodic: | |
| Wilhoit spring, Oregon | 421.97 |
| Saratoga Springs, New York: | |
| White Sulphur | 115.73 |
| Magnesic | 216.05 |
| Imperial | 269.20 |
| Vichy | 315.18 |
| New Putnam | 361.01 |
| Columbia | 407.30 |
| Peerless | 419.62 |
| Excelsior | 514.75 |
| Patterson | 518.18 |
| High Rock | 628.04 |
| Royal | 640.03 |
| Empire | 680.44 |
| Congress | 700.89 |
| Union | 701.17 |
| Carlsbad | 1,149.21 |
| Champion | 1,195.58 |
| Magnesia spring, Cresson Springs, Pennsylvania | 6.88 |
| De Profundis spring, Eureka Mineral Springs, Pennsylvania | 23.77 |
| Pacific Congress spring | 335.85 |
| Lansing Magnetic well, Michigan | 613.77 |
| Pulaski Mineral spring, Pennsylvania | 265.49 |
| Sulphureted sodic: | |
| Triplet Natural Mineral springs, West Virginia | 77.88 |
| Sulphocarbonated sodic: | |
| Coronado springs, California | 26.29 |
| White Sulphur spring, Byron Springs, California | 36.06 |
| Sodic-potassic | |
| Kalium springs, New Jersey | 5.70 |
| Sodic-magnesic: | |
| Aspinock spring, Connecticut | 2.21 |
| Carbonated sodic-magnesic: | |
| Azule Mineral well, California | 153.77 |
| Bedford Magnesic spring | 153.87 |
| Calcic: | |
| Holly spring, Rhode Island | 2.51 |
| Everett Crystal spring, Massachusetts | 13.63 |
| Calcic-sodic: | |
| Baca springs, New Mexico | 137.44 |
| Carbonated calcic-sodic: | |
| Soda springs, New Mexico | 153.84 |

## III. SALINE SPRINGS.

### 1. Sulphated.

| | |
|---|---|
| Sodic: | |
| Black Hawk springs, Illinois | 3.99 |
| Paraiso spring, California | 58.80 |
| Faris Magnetic well, Pueblo, Colorado | 62.03 |
| Palo Pinto Mineral wells, Texas | 226.23 |
| Haupt's Mineral spring, Missouri | 351.39 |
| Ottumwa Medical springs, Iowa | 356.45 |
| Carbonated sodic: | |
| Clarendon springs, Vermont | 5.76 |
| Page's well, Texas | 378.99 |
| Sodic-calcic: | |
| Magnetic springs and well, Michigan | 85.20 |
| Sodic-chalybeate: | |
| Stafford Mineral spring, Connecticut | 5.38 |

| | GRAINS PER GALLON. |
|---|---|
| CARBONATED SODIC-CHALYBEATE: | |
| Seltzer Mineral spring, Colorado | 293.72 |
| SULPHURETED POTASSIC-SODIC: | |
| Alburgh springs, Vermont | 38.00 |
| CALCIC: | |
| Daniel Mineral spring, Georgia | 108.61 |
| Flintstone Mineral springs, Maryland | 174.00 |
| Providence Mineral well, Kansas | 246.30 |
| CARBONATED CALCIC: | |
| Barium springs, North Carolina | 8.40 |
| Manhattan Artesian Mineral wells, Kansas | 117.94 |
| SULPHURETED CALCIC: | |
| Glen springs, South Carolina | 97.55 |
| Massena Sulphur springs, New York | 104.72 |
| CALCIC-SODIC: | |
| Dakota Hot springs, South Dakota | 58.33 |
| SULPHOCARBONATED CALCIC-SODIC MAGNESIC: | |
| Salt Sulphur springs, West Virginia | 200.20 |
| CALCIC-MAGNESIC: | |
| Hughes springs, Georgia | 86.42 |
| Geneva Magnetic Mineral springs, New York | 152.01 |
| CARBONATED CALCIC-MAGNESIC: | |
| Magnesia spring, Bedford Springs, Pennsylvania | 141.17 |
| Magnesia Iron spring, Bedford Springs, Pennsylvania | 153.30 |
| SULPHURETED CALCIC-MAGNESIC: | |
| Blue Ridge springs, Virginia | 159.66 |
| SULPHOCARBONATED CALCIC-MAGNESIC: | |
| Greenbrier White Sulphur springs, Virginia | 129.66 |
| CALCIC-MAGNESIC CHALYBEATE: | |
| Iron spring, Cresson Springs, Pennsylvania | 108.39 |
| SULPHOCARBONATED MAGNESIC CHALYBEATE: | |
| Spring No. 1, West Eldorado Springs, Missouri | 13.82 |
| CALCIC ALUMINO-MAGNESIC CHALYBEATE: | |
| Seven springs, Abingdon, Virginia | 99.76 |
| CHALYBEATE: | |
| Matchless Mineral Water well, Alabama | 601.62 |
| CARBONATED CHALYBEATE-SODIC MAGNESIC: | |
| Spring No. 5, West Eldorado Springs, Missouri | 9.63 |
| Spring No. 6, West Eldorado Springs, Missouri | 25.69 |
| CARBONATED CHALYBEATE-CALCIC MAGNESIC: | |
| Spring No. 2, Eldorado Springs, Missouri | 24.66 |
| Spring No. 4, Eldorado Springs, Missouri | 29.31 |
| CARBONATED CHALYBEATE-MAGNESIC: | |
| Spring No. 3, Eldorado Springs, Missouri | 22.01 |

### 2. MURIATED.

| | GRAINS PER GALLON. |
|---|---|
| SODIC: | |
| Black Hawk springs, Iowa | 34.10 |
| Cantonment spring, Florida | 42.88 |
| Prairie du Chien Artesian well, Wisconsin | 137.03 |
| Saint Patrick's well, Kentucky | 165.38 |
| Randolph springs, Missouri | 340.12 |
| Tolenas springs, California | 360.00 |
| Spring Lake Magnetic well, Michigan | 628.37 |
| Sheboygan Mineral spring, Wisconsin | 657.88 |
| CARBONATED SODIC: | |
| Diamond Mineral spring, Colorado | 104.90 |
| Sanicula springs, Illinois | 170.77 |
| Oneita springs, New York | 183.77 |
| Salutaris springs, Michigan | 222.20 |
| White Sulphur springs, Iowa | 296.49 |
| Deep Rock springs, New York | 559.18 |
| Great Spirit spring, Kansas | 1,120.76 |
| Byron springs: | |
| Iron Pipe spring | 668.14 |
| Hot Salt spring | 706.94 |
| CARBONATED SODIC—Continued. | |
| Byron springs—Continued. | |
| Liver and kidney spring | 769.05 |
| Surprise spring | 18,773.73 |
| SULPHURETED SODIC: | |
| Lodi Artesian well, Indiana | 672.45 |
| Ypsilanti Mineral well, Michigan | 1,205.69 |
| Mineral well, Mount Clemens mineral springs, Michigan | 13,654.33 |
| Sweet springs, Missouri: | |
| Sweet spring | 152.27 |
| Akesion spring | 1,061.94 |
| SULPHOCARBONATED SODIC: | |
| Ripley Bromo Lithia springs, Ohio | 75.17 |
| Rex Mineral spring, Ohio | 130.02 |
| Magnetic Mineral springs, Terre Haute, Indiana | 429.44 |
| Black Sulphur spring, Byron's Springs, California | 461.97 |
| Lower Blue Lick springs, Kentucky | 632.83 |
| Iron Spring, Byron's Springs, California | 765.64 |
| Spring No. 2, Blue Lick Springs, Missouri | 1,213.72 |
| Young's Medicinal wells, Missouri | 1,562.01 |
| CARBONATED-AZOTIZED SODIC: | |
| West Baden springs, No. 1, Indiana | 282.99 |
| SODIC-CALCIC: | |
| Parker Magnetic Mineral spring, Pennsylvania | 627.59 |
| SODIC-CALCIC MAGNESIC: | |
| Arkansas Lithia spring, Arkansas | 67.79 |
| CALCIC: | |
| Simpson springs, Massachusetts | 2.60 |
| SULPHURETED CALCIC-SODIC: | |
| Devonian Mineral spring, Ohio | 6,472.21 |
| CARBONATED CALCIC-CHALYBEATE: | |
| Maryland Strontia spring, Maryland | 74.76 |
| SULPHOCARBONATED POTASSIC: | |
| Peoria Magnetic Artesian springs, Illinois | 185.00 |

## IV. ACID SPRINGS.

### 1. SULPHATED.

| | GRAINS PER GALLON. |
|---|---|
| ALUMINO-CHALYBEATE: | |
| Alum spring, Stribling Springs, Virginia | 55.86 |
| Black Mountains Iron and Alum spring, North Carolina | 99.65 |
| CARBONATED ALUMINO-CHALYBEATE: | |
| Rockbridge Alum springs, Virginia: | |
| Chalybeate | 7.61 |
| Spring No. 6 | 17.94 |
| Spring No. 5 | 21.53 |
| Spring No. 4 | 27.09 |
| Spring No. 1 | 43.09 |
| Spring No. 8 | 52.73 |
| Spring No. 9 | 55.09 |
| Spring No. 3 | 61.77 |
| Spring No. 2 | 62.35 |
| Spring No. 7 | 116.27 |
| Wallawhatoola Alum springs, Virginia | 119.41 |
| ALUMINO-MAGNESIC CHALYBEATE: | |
| Elkhart Mineral wells, Texas: | |
| Well No. 2 | 143.81 |
| Well No. 3 | 169.28 |
| Well No. 1 | 181.51 |
| ALUMINO-CALCIC CHALYBEATE: | |
| Overall Mineral wells, Texas: | |
| Well No. 1 | 133.76 |
| Well No. 2 | 235.01 |
| CALCIC-ALUMINO-MAGNESIA CHALYBEATE: | |
| Texas Sour springs, Texas | 443.91 |
| CALCIC-MAGNESIC CHALYBEATE: | |
| Brown's wells, Mississippi | 266.23 |

## UNCLASSIFIED WATERS.

The following list includes all those springs which either did not furnish an analysis or of which the analysis was only partial or qualitative:

Healing Springs, Alabama.
Jackson White Sulphur Springs, Alabama.
Fairchild's Potash Sulphur Springs, Arkansas.
Hot Springs of Elsinore, California.
Ojai Hot Springs, California.
Boulder Spring, Colorado.
Clark Magnetic Mineral Spring, Colorado.
Hillsboro Mineral Spring, Illinois.
Red Avon Springs, Illinois.
Silver Springs Mineral Well, Illinois.
Ash Iron Spring, Indiana.
Buffalo Saline Well, Indiana.
Elliot's Mineral Springs, Indiana.
King Mineral Spring, Indiana.
Boiling Springs, Kansas.
Genda Mineral Springs, Kansas.
Osage Mission Mineral Well, Kansas.
Wichita Mineral Water Springs, Kansas.
Anita Springs, Kentucky.
Bedford Springs, Kentucky.
Seal Rock Spring, Maine.
Cecil Spring, Maryland.
Belmont Hill Spring, Massachusetts.
Zauber Wasser Well, Hudson, Michigan.
Artesian White Sulphur Well, Chester, Missouri.
Reiger Springs, Missouri.
Empire Seneca Spring, New York.
Lemon Springs, North Carolina.
Seven Springs, North Carolina.
Adams County Mineral Springs, Ohio.
Magnetic and Saline Spring, Marysville, Ohio.
Sulphur Lick Spring, Ohio.
Sizerville Magnetic Mineral Spring, Pennsylvania
Chick's Springs, South Carolina.
Estill Springs, Tennessee.
Idaho Springs, Tennessee.
Dalby Springs, Texas.
Capp's Mineral Water, Texas.
Hynson's Iron Mount Springs, Texas.
Montvale Springs, Texas.
Richards' Wells, Texas.
Roseborough Springs, Texas.
Slack's Wells, Texas.
Tioga Mineral Well, Texas.
Brunswick White Sulphur Springs, Vermont.
Hunter's Pulaski Alum Springs, Virginia.
Powhatan Lithia and Saline Spring, Virginia.
Rockingham Springs, Virginia.
Silver Sand Spring, Wisconsin.

# SPECIAL SCHEDULES

ISSUED BY THE CENSUS OFFICE FOR THE COLLECTION OF STATISTICS RELATING TO MINERAL INDUSTRIES IN THE UNITED STATES AT THE ELEVENTH CENSUS.

## LIST OF SPECIAL SCHEDULES.

No. 1. For minor minerals.
No. 2. Iron ore mines.
No. 3*a*. Gold and silver mines and reduction works.
No. 4. Copper mines.
No. 5. Lead mines.
No. 6. Zinc mines.
No. 9. Manganese ore mines.
No. 11. Precious stones.
No. 12. Coal mines.
No. 12*a*. Coal distribution.
No. 13. Quicksilver mines and reduction works.
No. 14. Crude petroleum.
No. 15. Natural gas.
No. 16. Stone quarries.
No. 17. Mineral waters.
No. 19. Lead smelters and refiners.
No. 20. Lead refiners.
No. 21. Zinc reduction works.

# SPECIAL SCHEDULES.

[TITLE PAGE PRECEDING EACH SPECIAL SCHEDULE.]

## ELEVENTH CENSUS OF THE UNITED STATES.

## STATISTICS OF MINES AND MINING.

DEPARTMENT OF THE INTERIOR,
CENSUS OFFICE,
WASHINGTON, D. C., January 1, 1890.

Dr. David T. Day, of the United States geological survey, has been appointed, in compliance with law, as the special agent of the Census Office in charge of the statistics relating to mines and mining.

The special agent thus appointed has all the authority of a census enumerator under the act of March 1, 1889, and is empowered to conduct in his own name all the correspondence relating to this branch of the work.

Mine operators and owners of works are hereby assured that their answers to the questions within will be held strictly confidential, and will not be disclosed to any unauthorized person whomsoever.

Special agents and enumerators are sworn officers of the government, and severe penalties are imposed by law for a violation of their obligations.

The data will not be used by this office as the basis of any system of taxation or license, or in any way to adversely affect the interest of miners or operators of mines or works. No publication will be made in the census reports which will disclose the names or operations of individuals.

Very respectfully,

ROBERT P. PORTER,
*Superintendent of Census.*

Approved:
JOHN W. NOBLE,
*Secretary of the Interior.*

[Extract from "An act to provide for taking the Eleventh and subsequent censuses".]

* * * * * * * * * * * *

SEC. 15. * * And every president, treasurer, secretary, agent, director, or other officer of every corporation from which answers to any of the schedules provided for by this act are herein required, who shall, if thereto requested by the superintendent, supervisor, or enumerator, willfully neglect or refuse to give true and complete answers to any inquiries authorized by this act, or shall willfully give false information, shall be guilty of a misdemeanor, and on conviction thereof shall be fined not exceeding ten thousand dollars, to which may be added imprisonment for a period not exceeding one year.

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## CERTIFICATE.

This is to certify that the information contained in this schedule is complete and correct to the best of my knowledge and belief.

[Signature.]

[Official designation.]

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### SPECIAL SCHEDULE NO. 1.—FOR MINOR MINERALS.

#### LOCATION.

1. Name of mine or works ..........
2. Location of mine:
    Mining district or region ..........
    County ..........
    State ..........
3. Name and post-office address of company, corporation, or individual operating the mine or works ..........
4. Name and post-office address of resident superintendent or agent ..........
5. Name of substance produced ..........

#### PRODUCT.

NOTE.—Use the long or short ton or other unit, according to your usual custom, but state definitely the number of pounds in the unit used. If any calculations are made, such as determining the total value of the product, it is requested that such calculations be made on the blank pages of this schedule. These blank pages may also be used for any remarks explanatory of the answers given.

6. Product for the year ended December 31, 1889:
    Total amount of crude material taken from the mine ..........
    Total amount of the substance in the condition in which it was first sold ..
7. Stock on hand, including that at mine or mill, in transit, and unsold in the hands of agents:
    (a) January 1, 1889 .......... ......
    (b) January 1, 1890 .......... ......
8. Total value of the year's product .......... $......

NOTE.—The value is to be taken at the stage in the preparation of the mineral at which it first becomes a marketable article and has a definite market price. For example: The price of mica is that at which it was first sold, whether in blocks, or rough, or cut sheets. If it is shipped to a distance before selling, the freight charges from the mine to the selling point should be given.

#### LABOR AND WAGES.

| CLASSIFICATION. | Average number employed. (*a*) | Average wages per day. (*b*) | Average number of days' work made by each class during the year. |
|---|---|---|---|
| 9. Labor: | | | |
| Above ground (not including office force): | | | |
| Foremen or overseers | | | |
| Mechanics | | | |
| Laborers (*c*) | | | |
| Boys under 16 | | | |
| Below ground (not including office force): | | | |
| Foremen or overseers | | | |
| Miners | | | |
| Laborers (*c*) | | | |
| Boys under 16 | | | |

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*a* In giving the number of men employed include those employed by contractors and subcontractors, as well as by the company itself.

*b* Wages must include value of board or rent furnished as part compensation.

*c* Laborers include watchmen, teamsters, and all workmen not otherwise classified.

### SPECIAL SCHEDULE NO. 1.—FOR MINOR MINERALS—Continued.

10. Wages:
Total amount of wages paid during 1889 ........ $......
Total amount paid to contractors for contract work done in 1889, not included in the above item, deducting supplies charged to them. $......

| | Number. | Total wages paid in 1889. |
|---|---|---|
| 11. Office force at mines or works: (*d*) | | |
| Males ........ | ........ | $........ |
| Females ........ | ........ | $........ |
| Total ........ | ........ | $........ |

*d* Where two or more mines with distinct organizations, and reported on separate census schedules, are directed and paid from one central office, the employés of such central office are not to be included in the table above. Please state on the blank page opposite the total number of males and females and their total yearly earnings, together with the names of the mines with whose administration such persons are connected.

12. Number of days during the year when the mines or works were idle, and the cause........

#### CAPITAL.

13. Total value of mine and improvements as at present developed...... $......
Distributed as follows:
In land........ $......
In buildings and fixtures........ $......
In tools, implements, live stock, machinery, and supplies on hand........ $......
In cash (not reported in the foregoing items)........ $......

NOTE.—In stating the amount of capital there should be included not only the amount of capital actually invested in the business, as in lands, leases, mineral rights, rights of way, private railroads, buildings, tools, and all other forms of property, but also that used in carrying on the business. This statement, to be complete, should include as capital all money borrowed, as well as accounts having a long time to run. The idea is to get returned as capital all money invested and used in the business, whether owned by the party making the return or borrowed. The value of land, fixtures, etc., should be estimated at what they are worth or would cost in 1890.

14. Power used in mining:
Number and total horse power of steam boilers..No.....; horse power......
Number and size of cylinders of steam engines........ ......
If other power, state kind........ ......
Number of motors ........; horse power......
15. Number of animals employed........ ......
16. Total value of supplies and materials of all kinds consumed during the year 1889........ $......
17. Total of all other expenditures for the mines or works (including amounts paid for rent, taxes, insurance, interest, etc.)........ $......

NOTE.—Remarks concerning uses for which your product has proved especially valuable, analyses, peculiar mining features, etc., will be gladly received, and should be noted on the blank pages.

### SPECIAL SCHEDULE NO. 2.—IRON ORE MINES.

#### LOCATION.

1. Name or designation of mine ........
2. Location of mine:
Mining district, range, or region........
County........
State........
3. Name and post-office address of company, corporation, or individual operating the mine or works ........
4. Name and post-office address of resident superintendent or agent........
5. Character of ore produced:
Brown hematite, limonite, or bog ore........
Red hematite, specular, or fossil ore ........
Magnetic ore........
Carbonate, siderite, spathic, or black-band ore ........

#### PRODUCT.

NOTE.—Use the long or short ton, according to your usual custom, but state definitely the number of pounds in the ton used. If any calculations are made, such as determining the total value of the product from the price per ton, it is requested that such calculations be made on the blank pages of this schedule. These blank pages may also be used for any remarks explanatory of the answers given.

### SPECIAL SCHEDULE NO. 2.—IRON ORE MINES—Continued.

6. Total amount of marketable iron ore produced in the year ended December 31, 1889, including the amount smelted at the mine ........
7. Total stock of ore on hand, including that at mine or furnace, in transit and unsold in hands of agents:
January 1, 1889........ ......
January 1, 1890........ ......
8. Total value of iron ore produced in 1889 at the prices received for ore delivered on cars or carts at the mine ........ $......
9. Principal markets and proportion of product sent to each market to which your ore is supplied........ ......

#### LABOR AND WAGES.

| CLASSIFICATION. | Average number employed. (*a*) | Average wages per day. (*b*) | Average number of days' work made by each class during the year. |
|---|---|---|---|
| 10. Labor: | | | |
| Above ground (not including office force): | | | |
| Foremen or overseers ...... | ...... | ...... | ...... |
| Mechanics ...... | ...... | ...... | ...... |
| Laborers (*c*)...... | ...... | ...... | ...... |
| Boys under 16 ...... | ...... | ...... | ...... |
| Below ground (not including office force): | | | |
| Foremen or overseers...... | ...... | ...... | ...... |
| Miners ...... | ...... | ...... | ...... |
| Laborers (*c*)...... | ...... | ...... | ...... |
| Boys under 16 ...... | ...... | ...... | ...... |

*a* In giving the number of men employed include those employed by contractors and subcontractors, as well as by the company itself.

*b* Wages must include value of board or rent furnished as part compensation.

*c* Laborers include watchmen, teamsters, and all workmen not otherwise classified.

11. Wages:
Total amount of wages paid to above during 1889........ $......
Total amount paid to contractors for contract work done in 1889, not included in the above item, deducting supplies charged to them.. $......
12. Office force at mines or works: (*d*)
Males ........No.... $......
Females ........No.... $......
Grand total of wages........ $......

*d* Where two or more mines with distinct organizations, and reported on separate census schedules, are directed and paid from one central office, the employés of such central office are not to be included in the table above. Please state on the blank page opposite the total number of males and females and their total yearly earnings, together with the names of the mines with whose administration such persons are connected.

13. Number of days during the year when the mines or works were idle, and the cause........

#### CAPITAL.

14. Total value of mine and improvements as at present developed....... $......
Distributed as follows:
In land........ $......
In buildings and fixtures ........ $......
In tools, implements, live stock, machinery, and supplies on hand ........ $......
In cash (not reported in the foregoing items)........ $......

NOTE.—In stating the amount of capital there should be included not only the amount of capital actually invested in the business, as in lands, leases, mineral rights, rights of way, private railroads, buildings, tools, and all other forms of property, but also that used in carrying on the business. This statement, to be complete, should include as capital all money borrowed, as well as accounts having a long time to run. The idea is to get returned as capital all money invested and used in the business, whether owned by the party making the return or borrowed. The value of land, fixtures, etc., should be estimated at what they are worth or would cost in 1890.

15. Power used in mining:
Number and total horse power of steam boilers... No....; horse power....
Number and size of cylinders of steam engines........ ......
If other power, state kind........ ......
Number of motors........ .....; horse power.......
16. Number of animals employed........ ......

### SPECIAL SCHEDULE NO. 2.—IRON ORE MINES—Continued.

17. Total value of supplies and materials of all kinds consumed during the year 1889 ........ $......

18. Total of all other expenditures for the mines or works (including amounts paid for rent, taxes, insurance, interest, etc.) ........ $......

NOTE.—Remarks showing the uses for which your product has proved especially valuable, analyses, etc., will be gladly received, and should be made upon the blank pages of this schedule.

### SPECIAL SCHEDULE NO. 3a.—GOLD AND SILVER MINES AND REDUCTION WORKS.

#### LOCATION.

1. Name of mine or works........

2. Location of mine or works:

Mining district or region........

County........

State........

3. Name and post-office address of company, corporation, or individual operating the mine or works........

4. Name and post-office address of resident superintendent or agent........

#### PRODUCT.

NOTE.—Use the long or short ton or other unit, according to your usual custom, but state definitely the number of pounds in the unit used. If any calculations are made, such as determining the total value of the product, etc., it is requested that such calculations be made on the blank pages of this schedule. These blank pages may also be used for any remarks explanatory of the answers given.

5. Total amount of ore produced in the year ended December 31, 1889 (tons of .... pounds) ........ ......

6. Total amount of ore sold or treated in 1889 (tons of....pounds) ........ ......

7. Total assay value of ore sold or treated in 1889:

Gold ........ $......

Silver ........ $......

NOTE.—Use coining value for silver, 1 ounce = $1.2929.

8. Where and by what process was the ore treated? ........

9. Bullion produced from ore treated in 1889:

| METALS. | Quantity. | Value. |
|---|---|---|
|  | *Ounces fine.* |  |
| Gold........ | ........ | $........ |
| Silver (value of ounce $1.2929)........ | ........ | $........ |
|  | *Pounds.* |  |
| Copper........ | ........ | $........ |
| Lead........ | ........ | $........ |
| Other metals (designate them)........ | ........ | $........ |
| Total........ | ........ | $........ |

#### LABOR AND WAGES.

| CLASSIFICATION. | Average number employed. (*a*) | Average wages per day. (*b*) | Average number of days' work made by each class during the year. |
|---|---|---|---|
| 10. Labor: |  |  |  |
| Above ground (not including office force): |  |  |  |
| Foremen or overseers........ | ........ | ........ | ........ |
| Mechanics........ | ........ | ........ | ........ |
| Laborers (*c*)........ | ........ | ........ | ........ |
| Boys under 16 ........ | ........ | ........ | ........ |
| Below ground (not including office force): |  |  |  |
| Foremen or overseers........ | ........ | ........ | ........ |
| Miners........ | ........ | ........ | ........ |
| Laborers (*c*)........ | ........ | ........ | ........ |
| Boys under 16 ........ | ........ | ........ | ........ |

*a* In giving the number of men employed include those employed by contractors and subcontractors, as well as by the company itself.

*b* Wages must include value of board or rent furnished as part compensation.

*c* Laborers include watchmen, teamsters, and all workmen not otherwise classified.

11. Number of days during the year when the mines or works were idle, and the cause........

### SPECIAL SCHEDULE NO. 3a.—GOLD AND SILVER MINES AND REDUCTION WORKS—Continued.

#### EXPENDITURES.

12. Wages:

Total amount of wages paid during 1889........ $......

Total amount paid to contractors for contract work done in 1889, not included in the above item, deducting supplies charged to them.. $......

13. Office force at mines or works: (*d*)

Males........ No.... $......

Females........ No.... $......

Grand total of wages........ $......

*d* Where two or more mines with distinct organizations, and reported on separate census schedules, are directed and paid from one central office, the employés of such central office are not to be included in the table above. Please state on the blank page opposite the total number of males and females and their total yearly earnings, together with the names of the mines with whose administration such persons are connected.

14. Total value of supplies and materials of all kinds consumed during the year 1889 ........ $......

15. Total of all other expenditures for the mines or works (including amounts paid for rent, taxes, insurance, interest, etc.) ........ $......

16. Grand total of expenditures ........ $......

NOTE.—In stating the amount of capital there should be included not only the amount of capital actually invested in the business, as in lands, leases, mineral rights, rights of way, private railroads, buildings, tools, and all other forms of property, but also that used in carrying on the business. This statement, to be complete, should include as capital all money borrowed, as well as accounts having a long time to run. The idea is to get returned as capital all money invested and used in the business, whether owned by the party making the return or borrowed. The value of land, fixtures, etc., should be estimated at what they are worth or would cost in 1890.

#### VALUE OF MINING PROPERTY.

17. Total present actual cash value of the mine and mining plant ........ $......

Distributed as follows:

Present actual cash value of buildings at mine........ $......

Present actual cash value of railroads on surface........ $......

Present actual cash value of machinery of all kinds above and below ground, including pumps, engines, boilers, cars, tools, etc ........ $......

Present actual cash value of underground improvements, including shafts, tunnels, drifts, tramways, etc ........ $......

Present actual cash value of mine supplies of all kinds on hand December 31, 1889 ........ $......

Present actual cash value of the mine itself exclusive of above items........ $......

Cash not reported in the foregoing items........ $......

18. Value of mill, smelting, or other reduction works (exclusive of mining property):

State character of works, whether concentrating, amalgamating, chlorinating, smelting, or other works........

Present actual cash value of buildings ........ $......

Present actual cash value of machinery and plant of all kinds, except buildings........ $......

Present actual cash value of supplies on hand December 31, 1889. $......

Total cash value of works........ $......

19. Power used in mining:

Number and total horse power of steam boilers....; No....; horse power....

Number and size of cylinders of steam engines........ ......

If other power, state kind........ ......

Number of motors........; horse power ........ ......

20. Number of animals employed........ ......

### SPECIAL SCHEDULE NO. 4.—COPPER MINES.

#### LOCATION.

1. Name of mine or works........

2. Location of mine:

Mining district or region........

County........

State........

3. Name and post-office address of company, corporation, or individual operating the mine or works........

4. Name and post-office address of resident superintendent or agent........

#### PRODUCT.

NOTE.—Use the long or short ton or other unit, according to your usual custom, but state definitely the number of pounds in the unit used. If any calculations are made, such as determining the total value of the product, it is requested that such calculations be made on the blank pages of this schedule. These blank pages may also be used for any remarks explanatory of the answers given.

### SPECIAL SCHEDULE No. 4.—COPPER MINES—Continued.

5. Total amount of ore produced in the year ended December 31, 1889 .... ......
   Total amount of concentrates, if concentrating is used.............. ......
   Total amount of matte produced ...................................... ......
   Total amount of blister or black copper produced .................... ......
   Copper contents of product as sold, whether ore, concentrates, matte, or blister ..........
6. Total stock of ore on hand, including that at mine, mill, or smelter, in transit, and unsold in hands of agents:
   January 1, 1889.............................................. ......
   January 1, 1890.............................................. ......

LABOR AND WAGES.

| CLASSIFICATION. | Average number employed. (*a*) | Average wages per day. (*b*) | Average number of days' work made by each class during the year. |
|---|---|---|---|
| 7. Labor: | | | |
| Above ground (not including office force): | | | |
| Foremen or overseers...... | | | |
| Mechanics.................. | | | |
| Laborers (*c*) .............. | | | |
| Boys under 16 .............. | | | |
| Below ground (not including office force): | | | |
| Foremen or overseers...... | | | |
| Miners ..................... | | | |
| Laborers (*c*) .............. | | | |
| Boys under 16 .............. | | | |

*a* In giving the number of men employed include those employed by contractors and subcontractors, as well as by the company itself.

*b* Wages must include value of board or rent furnished as part compensation.

*c* Laborers include watchmen, teamsters, and all workmen not otherwise classified.

8. Wages:
   Total amount of wages paid above during 1889 ..................... $......
   Total amount paid to contractors for contract work done in 1889, not included in the above item, deducting supplies charged to them.. $......
9. Office force at mines or works: (*d*)
   Males ..................................................No.... $......
   Females ................................................No.... $......
   Total ........................................................ $......

*d* Where two or more mines with distinct organizations, and reported on separate census schedules, are directed and paid from one central office, the employés of such central office are not to be included in the table above. Please state on the blank page opposite the total number of males and females and their total yearly earnings, together with the names of the mines with whose administration such persons are connected.

10. Number of days during the year when the mines or works were idle, and the cause ...................................................... ......

CAPITAL.

11. Total value of mine and improvements as at present developed....... $......
   Distributed as follows:
   In land....................................................... $......
   In buildings and fixtures ..................................... $......
   In tools, implements, live stock, machinery, and supplies on hand ........................................................ $......
   In cash (including all capital not reported in the foregoing items) ...................................................... $......

NOTE.—In stating the amount of capital there should be included not only the amount of capital actually invested in the business, as in lands, leases, mineral rights, rights of way, private railroads, buildings, tools, and all other forms of property, but also that used in carrying on the business. This statement, to be complete, should include as capital all money borrowed, as well as accounts having a long time to run. The idea is to get returned as capital all money invested and used in the business, whether owned by the party making the return or borrowed. The value of land, fixtures, etc., should be estimated at what they are worth or would cost in 1890.

12. Power used in mining:
   Number and total horse power of steam boilers..No.....; horse power.....
   Number and size of cylinders of steam engines..................... ......
   If other power, state kind........................................ ......
   Number of motors...............; horse power ..................... ......
13. Number of animals employed......................................... ......
14. Total value of supplies and materials of all kinds consumed during the year 1889 ................................................ $......

### SPECIAL SCHEDULE No. 4.—COPPER MINES—Continued.

15. Total of all other expenditures for the mines or works (including amounts paid for rent, taxes, insurance, interest, etc.) ............... $......

### SPECIAL SCHEDULE No. 5.—LEAD MINES.

LOCATION.

1. Name of mine or works.................................................
2. Location of mine:
   Mining district or region............................................
   County...............................................................
   State ...............................................................
3. Name and post-office address of company, corporation, or individual operating the mine or works ...............................................
4. Name and post-office address of resident superintendent or agent ............

PRODUCT.

NOTE.—Use the long or short ton or other unit, according to your usual custom, but state definitely the number of pounds in the unit used. If any calculations are made, such as determining the total value of the product, it is requested that such calculations be made on the blank pages of this schedule. These blank pages may also be used for any remarks explanatory of the answers given.

5. Total amount of ore produced in the year ended December 31, 1889.... ......
6. Total amount of refined lead produced in 1889.......................... ......
7. Total stock of ore on hand, including that at mine or furnace, in transit, and unsold in hands of agents:
   January 1, 1889 ................................................. ......
   January 1, 1890 ................................................. ......
   Principal markets for the ore.................................... ......

LABOR AND WAGES.

| CLASSIFICATION. | Average number employed. (*a*) | Average wages per day. (*b*) | Average number of days' work made by each class during the year. |
|---|---|---|---|
| 8. Labor: | | | |
| Above ground (not including office force): | | | |
| Foremen or overseers...... | | | |
| Mechanics.................. | | | |
| Laborers (*c*).............. | | | |
| Boys under 16.............. | | | |
| Below ground (not including office force): | | | |
| Foremen or overseers...... | | | |
| Miners ..................... | | | |
| Laborers (*c*).............. | | | |
| Boys under 16.............. | | | |

*a* In giving the number of men employed include those employed by contractors and subcontractors, as well as by the company itself.

*b* Wages must include value of board or rent furnished as part compensation.

*c* Laborers include watchmen, teamsters, and all workmen not otherwise classified in the schedule.

9. Wages:
   Total amount of wages paid above during 1889....................... $......
   Total amount paid to contractors for contract work done in 1889, not included in the above item, deducting supplies charged to them.. $......
10. Office force at mines or works: (*d*)
   Males ..................................................No.... $......
   Females.................................................No.... $......
   Total ........................................................ $......

*d* Where two or more mines with distinct organizations, and reported on separate census schedules, are directed and paid from one central office, the employés of such central office are not to be included in the table above. Please state on the blank page opposite the total number of males and females and their total yearly earnings, together with the names of the mines with whose administration such persons are connected.

11. Number of days during the year when the mines or works were idle, and the cause ...................................................... ......

CAPITAL.

12. Total value of mine and improvements as at present developed....... $......
   Distributed as follows:
   In land....................................................... $......
   In buildings and fixtures..................................... $......
   In tools, implements, live stock, machinery, and supplies on hand ........................................................ $......
   In cash (including all capital not reported in the foregoing items)...................................................... $......

### SPECIAL SCHEDULE No. 5.—LEAD MINES—Continued.

**NOTE.**—In stating the amount of capital there should be included not only the amount of capital actually invested in the business, as in lands, leases, mineral rights, rights of way, private railroads, buildings, tools, and all other forms of property, but also that used in carrying on the business. This statement, to be complete, should include as capital all money borrowed, as well as accounts having a long time to run. The idea is to get returned as capital all money invested and used in the business, whether owned by the party making the return or borrowed. The value of land, fixtures, etc., should be estimated at what they are worth or would cost in 1890.

**13.** Power used in mining:
  Number and total horse power of steam boilers..No. .....; horse power.....
  Number and size of cylinders of steam engines ..... .....
  If other power, state kind..... .....
  Number of motors.....; horse power..... .....
**14.** Number of animals employed..... .....
**15.** Total value of supplies and materials of all kinds consumed during the year 1889..... $.....
**16.** Total of all other expenditures for the mines or works (including amounts paid for rent, taxes, insurance, interest, etc.)..... $.....

### SPECIAL SCHEDULE No. 6.—ZINC MINES.

#### LOCATION.

**1.** Name of mine or works .....
**2.** Location of mine:
  Mining district or region .....
  County .....
  State.....
**3.** Name and post-office address of company, corporation, or individual operating the mine or works .....
**4.** Name and post-office address of resident superintendent or agent .....

#### PRODUCT.

**NOTE.**—Use the long or short ton or other unit, according to your usual custom, but state definitely the number of pounds in the unit used. If any calculations are made, such as determining the total value of the product, it is requested that such calculations be made on the blank pages of this schedule. These blank pages may also be used for any remarks explanatory of the answers given.

**5.** Total amount of ore produced in the year ended December 31, 1889..... .....
**6.** Total amount of refined spelter produced in 1889..... .....
**7.** Total stock of ore on hand, including that at mine, mill, or smelter, in transit and unsold in hands of agents:
  January 1, 1889..... .....
  January 1, 1890..... .....

#### LABOR AND WAGES.

| CLASSIFICATION. | Average number employed. (*a*) | Average wages per day. (*b*) | Average number of days' work made by each class during the year. |
|---|---|---|---|
| **8.** Labor: | | | |
| Above ground (not including office force): | | | |
| Foremen or overseers | ..... | ..... | ..... |
| Mechanics | ..... | ..... | ..... |
| Laborers (*c*) | ..... | ..... | ..... |
| Boys under 16 | ..... | ..... | ..... |
| Below ground (not including office force): | | | |
| Foremen or overseers | ..... | ..... | ..... |
| Miners | ..... | ..... | ..... |
| Laborers (*c*) | ..... | ..... | ..... |
| Boys under 16 | ..... | ..... | ..... |

*a* In giving the number of men employed include those employed by contractors and subcontractors, as well as by the company itself.

*b* Wages must include value of board or rent furnished as part compensation.

*c* Laborers include watchmen, teamsters, and all workmen not otherwise classified.

**9.** Wages:
  Total amount of wages paid above during 1889..... $.....
  Total amount paid to contractors for contract work done in 1889, not included in the above item, deducting supplies charged to them..... $.....

### SPECIAL SCHEDULE No. 6.—ZINC MINES—Continued.

10. Office force at mines or works: (*d*)
  Males.....No.... $.....
  Females.....No.... $.....
    Grand total of wages..... $.....

*d* Where two or more mines with distinct organizations, and reported on separate census schedules, are directed and paid from one central office, the employés of such central office are not to be included in the table above. Please state on the blank page opposite the total number of males and females and their total yearly earnings, together with the names of the mines with whose administration such persons are connected.

11. Number of days during the year when the mines or works were idle, and the cause ..... .....

#### CAPITAL.

12. Total value of mine and improvements as at present developed..... $.....
  Distributed as follows:
    In land..... $.....
    In buildings and fixtures ..... $.....
    In tools, implements, live stock, machinery, and supplies on hand..... $.....
    In cash (not reported in the foregoing items) ..... $.....

**NOTE.**—In stating the amount of capital there should be included not only the amount of capital actually invested in the business, as in lands, leases, mineral rights, rights of way, private railroads, buildings, tools, and all other forms of property, but also that used in carrying on the business. This statement, to be complete, should include as capital all money borrowed, as well as accounts having a long time to run. The idea is to get returned as capital all money invested and used in the business, whether owned by the party making the return or borrowed. The value of land, fixtures, etc., should be estimated at what they are worth or would cost in 1890.

13. Power used in mining:
  Number and total horse power of steam boilers..No....; horse power.....
  Number and size of cylinders of steam engines..... .....
  If other power, state kind..... .....
  Number of motors.....; horse power..... .....
14. Number of animals employed ..... .....
15. Total value of supplies and materials of all kinds consumed during the year 1889 ..... $.....
16. Total of all other expenditures for the mines or works (including amounts paid for rent, taxes, insurance, interest, etc.) ..... $.....

### SPECIAL SCHEDULE No. 9.—MANGANESE ORE MINES.

#### LOCATION.

1. Name or designation of mine .....
2. Location of mine:
  Mining district, region, or range .....
  County .....
  State.....
3. Name and post-office address of company, corporation, or individual operating the mine or works.....
4. Name and post-office address of resident superintendent or agent.....
5. Character of ore produced:
  Bog manganese, wad .....
  Braunite, brown oxide .....
  Pyrolusite, black oxide, peroxide.....
  Hausmannite .....

#### PRODUCT.

**NOTE.**—Use the long or short ton, according to your usual custom, but state definitely the number of pounds in the ton used. If any calculations are made, such as determining the total value of the product from the price per ton, it is requested that such calculations be made on the blank pages of this schedule. These blank pages may also be used for any remarks explanatory of the answers given.

6. Total amount of marketable manganese ore produced in the year ended December 31, 1889, including the amount smelted at the mine..... .....
7. Total stock of ore on hand, including that at mine or furnace, in transit, and unsold in hands of agents:
  January 1, 1889..... .....
  January 1, 1890..... .....
8. Total value, on cars or carts at the mine, of manganese ore produced in 1889 ..... $.....
9. Principal markets, and proportion of product sent to each market to which your ore is supplied .....

## SPECIAL SCHEDULE NO. 9.—MANGANESE ORE MINES—Continued.

### LABOR AND WAGES.

| CLASSIFICATION. | Average number employed. (*a*) | Average wages per day. (*b*) | Average number of days' work made by each class during the year. |
|---|---|---|---|
| **10.** Labor: | | | |
| Above ground (not including office force): | | | |
| Foremen or overseers | | | |
| Mehanics | | | |
| Laborers (*c*) | | | |
| Boys under 16 | | | |
| Below ground (not including office force): | | | |
| Foremen or overseers | | | |
| Miners | | | |
| Laborers (*c*) | | | |
| Boys under 16 | | | |

*a* In giving the number of men employed include those employed by contractors and subcontractors, as well as by the company itself.

*b* Wages must include value of board or rent furnished as part compensation.

*c* Laborers include watchmen, teamsters, and all workmen not otherwise classified.

**11.** Wages:
Total amount of wages paid above during 1889 $......
Total amount paid to contractors for contract work done in 1889, not included in the above item, deducting supplies charged to them $......

**12.** Office force at mines or works: (*d*)
Males No.... $......
Females No.... $......
Grand total of wages $......

*d* Where two or more mines with distinct organizations, and reported on separate census schedules, are directed and paid from one central office, the employés of such central office are not to be included in the table above. Please state on the blank page opposite the total number of males and females and their total yearly earnings, together with the names of the mines with whose administration such persons are connected.

**13.** Number of days during the year when the mines or works were idle, and the cause ......

### CAPITAL.

**14.** Total value of mine and improvements as at present developed $......
Distributed as follows:
In land $......
In buildings and fixtures $......
In tools, implements, live stock, machinery, and supplies on hand $......
In cash (not reported in the foregoing items) $......

NOTE.—In stating the amount of capital there should be included not only the amount of capital actually invested in the business, as in lands, leases, mineral rights, rights of way, private railroads, buildings, tools, and all other forms of property, but also that used in carrying on the business. This statement, to be complete, should include as capital all money borrowed, as well as accounts having a long time to run. The idea is to get returned as capital all money invested and used in the business, whether owned by the party making the return or borrowed. The value of land, fixtures, etc., should be estimated at what they are worth or would cost in 1890.

**15.** Power used in mining:
Number and total horse power of steam boilers . . No .....; horse power......
Number and size of cylinders of steam engines ......
If other power, state kind ......
Number of motors ......; horse power ......

**16.** Number of animals employed ......

**17.** Total value of supplies and materials of all kinds consumed during the year 1889 $......

**18.** Total of all other expenditures for the mines or works (including amounts paid for rent, taxes, insurance, interest, etc.) $......

## SPECIAL SCHEDULE NO. 11.—PRECIOUS STONES.

### 1. PRODUCTION OF ROUGH PRECIOUS STONES, GEMS, AND ORNAMENTAL STONES IN THE UNITED STATES IN 1889.

| NAME OF FINDER. | Post-office address of finder. | Name and post-office address of present owner. | Names of stones found. | Number of stones found. | Total value of stones before cutting. | Value after cutting into gems. | Value after cutting into watch jewels. | Value after cutting into cabinet specimens, polished on one or more sides. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |

### LABOR AND WAGES.

| DESCRIPTION. | Diamonds. | Rubies, sapphires, and all stones not elsewhere specified. | Agate, moss-agate, jasper, etc. |
|---|---|---|---|
| **2.** In cutting and polishing: | | | |
| Amount of material cut | | | |
| Value of above material | | | |
| Weight of above material | | | |
| Number of men employed | | | |
| Average wages per day (*a*) | | | |
| Number of boys employed | | | |
| Average wages per day (*a*) | | | |

*a* Wages must include value of board or rent furnished as part compensation.

**3.** Wages:
Total amount of wages paid all classes during 1889 $......

**4.** Number of days during the year when the cutting outfit was idle, and the cause ......

### CAPITAL.

**5.** Total value of cutting outfit $......
Distributed as follows:
In buildings and fixtures $......
In tools, implements, machinery, and supplies on hand $......
In cash (not reported in the foregoing items) $......

**6.** Power used in cutting:
Number and total horse power of steam boilers . . No....; horse power......
Number and size of cylinders of steam engines ......
If other power, state kind ......
Number of motors ......; horse power ......

**7.** Total value of supplies and materials of all kinds consumed during the year 1889 $......

**8.** Total of all other expenditures for the establishment (including amounts paid for rent, taxes, insurance, interest, etc.) $......

NOTE.—Remarks concerning the methods of cutting employed, etc., will be gladly received, and should be noted on the blank pages.

**9.** Names and addresses of other producers or cutters of precious stones, gems, or ornamental stones:

| NAMES. | Addresses. | Character of stones produced. |
|---|---|---|
| | | |
| | | |
| | | |

## SPECIAL SCHEDULE NO. 12.—COAL MINES.

### LOCATION.

1. Name of mine ......
2. Location of mine:
Mining district or region ......
County ......
State ......
Name and distance of nearest railroad station ......

### SPECIAL SCHEDULE No. 12.—COAL MINES—Continued.

3. Name and post-office address of company, corporation, or individual operating the mine or works........................................

4. Name and post-office address of resident superintendent or agent ............

5. Character of coal produced:
(Whether, anthracite, semibituminous, bituminous, or lignite)............

#### PRODUCT.

NOTE.—Use the long or short ton or other unit, according to your usual custom, but state definitely the number of pounds in the unit used. If any calculations are made, such as determining the total value of the product from the price per ton or bushel, it is requested that such calculations be made on the blank pages of this schedule. These blank pages may also be used for any remarks explanatory of the answers given.

6. Total product of coal of all grades in the year ended December 31, 1889 ......

7. Disposition of total product:
   a. Loaded at mines for shipment on railroad cars and boats ........ ......
   b. Sold to local trade at mines ........................................ ......
   c. Used by employés .................................................... ......
   d. Used for steam, ventilating, and heating purposes by operator at mines .................................................... ......
   e. Manufactured into coke ............................................ ......

8. Maximum production for any month during 1889, with name of month. ......

9. Total amount received for coal sold in 1889 ........................... $......

10. Average price of coal on cars at the mine: (If price is made at a distance from the mine, the freight should be mentioned.)............ $......

#### LABOR AND WAGES.

| CLASSIFICATION. | Average number employed. (a) | Average wages per day. (b) | Average number of days' work made by each class during the year. |
|---|---|---|---|
| 11. Labor: | | | |
| Above ground (not including office force): | | | |
| Foremen or overseers..... | ............ | ............ | ............ |
| Mechanics ........... | ............ | ............ | ............ |
| Laborers (c)........... | ............ | ............ | ............ |
| Boys under 16 | ............ | ............ | ............ |
| Below ground (not including office force): | | | |
| Foremen or overseers..... | ............ | ............ | ............ |
| Miners ........... | ............ | ............ | ............ |
| Laborers (c)........... | ............ | ............ | ............ |
| Boys under 16 ........... | ............ | ............ | ............ |

*a* In giving the number of men employed include those employed by contractors and subcontractors, as well as by the company itself.

*b* Wages must include value of board or rent furnished as part compensation.

*c* Laborers include watchmen, teamsters, and all workmen not otherwise classified.

12. Wages:
Total amount of wages paid above during 1889.......................... $......
Total amount paid to contractors for contract work done in 1889, not included in the above item, deducting supplies charged to them.. $......

13. Office force at mines or works: (*d*)
Males ...................................................... No.... $......
Females..................................................... No.... $......
Grand total of wages.......................................... $......

*d* Where two or more mines with distinct organizations, and reported on separate census schedules, are directed and paid from one central office, the employés of such central office are not to be included in the table above. Please state on the blank page opposite the total number of males and females and their total yearly earnings, together with the names of the mines with whose administration such persons are connected.

14. Number of days during the year when the mines or works were idle, and the cause.................................................... ......

#### CAPITAL.

15. Total value of mine and improvements as at present developed ...... $......
Distributed as follows:
In land ........................... acres, ..............; value, $......
In buildings and fixtures........................................ $......
In tools, implements, live stock, machinery, and supplies on hand ........................................................... $......
In cash (not reported in the foregoing items)........................ $......

NOTE.—In stating the amount of capital there should be included not only the amount of capital actually invested in the business, as in lands, leases, mineral rights, rights of way, private railroads, buildings, tools, and all other forms of property, but also that used in carrying on the business. This statement, to be complete, should include as capital all money borrowed, as well as accounts having a long time to run. The idea is to get returned as capital all money invested and used in the business, whether owned by the party making the return or borrowed. The value of land, fixtures, etc., should be estimated at what they are worth or would cost in 1890.

16. Power used in mining:
Number and total horse power of steam boilers...No.....; horse power......
Number and size of cylinders of steam engines ...................... ......
If other power, state kind ........................................ ......
Number of motors ........................; horse power.......... ......
Number and kind of mining machines ................................ ......

17. Number of animals employed .......................................... ......

18. Total value of supplies and materials of all kinds consumed during the year 1889.................................................... $......

19. Total of all other expenditures for the mines or works (including amounts paid for rent, taxes, insurance, interest, etc.)............... $......

### SPECIAL SCHEDULE No. 12a.—COAL DISTRIBUTION.

#### GENERAL INSTRUCTIONS.

Page 3 is intended only for reports from railroads; page 5 for canals and inland waterways, and page 7 for harbor and wharf masters.

Persons receiving this schedule will therefore fill out only the page designed for their report and leave the other two pages blank.

#### SPECIAL INSTRUCTIONS.

##### COAL TRANSPORTED BY RAILROADS.

For item 1 give in the proper columns the aggregate quantity of coal delivered to stations on your line for local consumption there, including engine supply and all coal for company use.

If your road traverses two or more states, give quantity separately for each state.

For item 2 give quantity delivered to each connecting line, with name of road and point of transfer.

For item 3 give name or location of port or wharves, and quantity delivered at each.

For item 4, although included in the aggregate of item 1, it is desired that the quantity delivered for consumption at each of the places named be given separately.

Give figures in tons, and note at foot of page the number of pounds in the ton as used by you.

##### COAL TRANSPORTED BY RAILROADS.

| INQUIRIES. | MINED ON LINE OF ROAD. | | RECEIVED FROM CONNECTING LINES. | |
|---|---|---|---|---|
| | Anthracite. | Bituminous. | Anthracite. | Bituminous. |
| 1. Quantity delivered for consumption to all stations on your line in the state of— | | | | |
| .................. | ............ | ............ | ............ | ............ |
| 2. Quantity delivered to connecting lines: | | | | |
| .................. | ............ | ............ | ............ | ............ |
| 3. Quantity delivered to shipping wharves for subsequent water transportation: | | | | |
| .................. | ............ | ............ | ............ | ............ |
| Total tonnage....... | ............ | ............ | ............ | ............ |
| 4. Quantity delivered for consumption at each of the following points: | | | | |
| .................. | ............ | ............ | ............ | ............ |

#### SPECIAL INSTRUCTIONS.

##### CANALS AND INLAND WATERWAYS.

For item 1 give in the proper columns the aggregate quantity of coal delivered or forwarded by you for local consumption at destination, giving aggregate quantity for each state separately.

For item 2 give quantity delivered at ports or wharves for further transportation, naming delivery points and quantity to each.

Item 3. Although the coal covered by this item is included in the aggregate of item 1, it is desired that the quantity delivered for consumption at each of the places named be given separately.

Give figures in tons, and note at foot of page the number of pounds in the ton as used by you.

### SPECIAL SCHEDULE No. 12*a*.—COAL DISTRIBUTION—Continued.

#### COAL TRANSPORTED BY CANALS AND INLAND WATERWAYS.

| INQUIRIES. | RECEIVED DIRECT FROM MINES. | | RECEIVED FROM OTHER TRANSPORTATION LINES. | |
|---|---|---|---|---|
| | Anthracite. | Bituminous. | Anthracite. | Bituminous. |
| 1. Quantity delivered for consumption to points in the state of— | | | | |
| 2. Quantity delivered for further transportation by rail at— | | | | |
| Total | | | | |
| 3. Quantity delivered for consumption at each of the following points: | | | | |

### SPECIAL INSTRUCTIONS.

#### COAL SHIPPED FROM PORTS AND WHARVES.

For item 1 give in the proper columns the aggregate quantity of coal shipped or transferred at your port.

If shipped by vessel, give points of destination and aggregate quantity to each point.

If delivered direct to a railroad, give name of road and quantity so delivered.

For item 2 give aggregate of shipments to each foreign port.

Give figures in tons, and note at foot of page the number of pounds in the ton as used by you.

#### COAL SHIPPED BY VESSEL OR RAIL FROM PORTS AND WHARVES.

| INQUIRIES. | SHIPPED BY WATER. | | SHIPPED BY RAIL. | |
|---|---|---|---|---|
| | Anthracite. | Bituminous. | Anthracite. | Bituminous. |
| 1. Quantity shipped to domestic points, as follows: | | | | |
| 2. Quantity shipped to foreign ports, as follows: | | | | |

### SPECIAL SCHEDULE No. 13.—QUICKSILVER MINES AND REDUCTION WORKS.

#### LOCATION.

1. Name of mine and works
2. Location of mine and works:
   - Mining district or region
   - County
   - State
3. Name and post-office address of company, corporation, or individual operating the mine and works
4. Name and post-office address of resident superintendent or agent
5. Number of furnaces in operation in December, 1889
6. Number of furnaces not in operation in December, 1889

#### PRODUCT.

NOTE.—Use the short ton of 2,000 pounds. If any calculations are made, such as determining the total value of the supplies, etc., it is requested that such calculations be made on the blank pages of this schedule. These blank pages may also be used for any remarks explanatory of the answers given.

7. Total number of tons of ore produced in the year ended December 31, 1889
8. Total number of tons of ore roasted in the year ended December 31, 1889
9. Total number of tons of quicksilver produced in 1889
10. Total number of flasks of quicksilver produced in 1889
11. Average percentage yield of quicksilver from ore roasted in 1889

### SPECIAL SCHEDULE No. 13.—QUICKSILVER MINES AND REDUCTION WORKS—Continued.

#### LABOR AND WAGES.

| CLASSIFICATION. | Average number employed daily. (*a*) | Average wages per day. (*b*) | Average number of days' work made by each class during the year. |
|---|---|---|---|
| 12. Labor: | | | |
| Above ground (not including office force): | | | |
| Foremen or overseers | | | |
| Mechanics | | | |
| Laborers (*c*) | | | |
| Boys under 16 | | | |
| Below ground (not including office force): | | | |
| Foremen or overseers | | | |
| Miners | | | |
| Laborers (*c*) | | | |
| Boys under 16 | | | |

*a* In giving the number of men employed include those employed by contractors and subcontractors, as well as by the company itself.

*b* Wages must include value of board or rent furnished as part compensation.

*c* Laborers include watchmen, teamsters, and all workmen not otherwise classified.

13. Wages:
   - Total amount of wages paid above during 1889 $
   - Total amount paid to contractors for contract work done in 1889, not included in the above item, deducting supplies charged to them $
14. Office force at mines or works: (*d*)
   - Males No. $
   - Females No. $
   - Total $

*d* Where two or more mines with distinct organizations, and reported on separate census schedules, are directed and paid from one central office, the employés of such central office are not to be included in the table above. Please state on the blank page opposite the total number of males and females and their total yearly earnings, together with the names of the mines with whose administration such persons are connected.

15. Number of days during the year when the mines or works were idle, and the cause

#### CAPITAL.

16. Total value of mines and improvements as at present developed $
   - Distributed as follows:
     - In mines and real estate $
     - In furnaces, houses, and other surface improvements $
     - In machinery, supplies on hand, tools, and live stock $
     - In quicksilver unsold January 1, 1889. No. of flasks ; value $
     - In bills and accounts receivable $
     - In any other assets $

NOTE.—In stating the amount of capital there should be included the capital invested in the business, as in lands, leases, mineral rights, rights of way, private railroads, buildings, tools, and all other forms of property. This statement, to be complete, should include as capital all accounts having time to run. The idea is to get returned as capital all money invested and used in the business, whether owned by the party making the return or borrowed. The value of land, fixtures, etc., should be estimated at what they are worth or would cost on January 1, 1890, and quicksilver unsold should include all at works or elsewhere at that date.

17. Power used in mining:
   - Number and total horse power of steam boilers No. ; horse power
   - Number and size of cylinders of steam engines
   - If other power, state kind
   - Number of motors ; horse power
18. Number of animals employed
19. Total value of supplies and materials of all kinds consumed during the year 1889 $
20. Total of all other expenditures for the mines or works (including amounts paid for rent, taxes, insurance, interest, etc.) $

## SPECIAL SCHEDULE No. 14.—CRUDE PETROLEUM.

NOTE.—The questions asked in this schedule relate only to the production of crude petroleum, its storage at the wells, and its distribution from the wells. It is not intended to include any statements regarding refineries, the transportation of petroleum from the wells by pipe lines, or the storage of petroleum by the pipe lines or at refineries. Special schedules will be furnished for these statements.

### LOCATION.

1. Location of wells reported in this schedule:
   Oil district, if known by any special name ......
   City, town, or township ......
   County ......; state ......

NOTE.—It is desired, if parties own wells in more than one city, town, or township, that separate returns be made for each city, town, etc. When this is not possible, please report the production of each county separately. Additional schedules will be furnished, if desired.

2. Name and post-office address of company, corporation, or individual operating the wells ......

### PRODUCTION.

3. Product by months:

[Barrels of 42 gallons.]

| MONTHS. | Crude, for illuminating. | Crude, for lubricating. | Fuel oil. | Total. |
|---|---|---|---|---|
| 1889. | | | | |
| January | | | | |
| February | | | | |
| March | | | | |
| April | | | | |
| May | | | | |
| June | | | | |
| July | | | | |
| August | | | | |
| September | | | | |
| October | | | | |
| November | | | | |
| December | | | | |
| Total | | | | |

4. Total value at wells of all oil produced, excluding pipage:
   Illuminating ...... $......
   Lubricating ...... $......
   Fuel oil ...... $......
   Total ...... $......

5. Stock at well:

NOTE.—In this table give only stocks at wells, not including any stocks that may be held by you in pipe lines and represented by pipe-line certificates. If you have a pipe line and tanks away from wells for your exclusive use, make report of same on a schedule that will be furnished for that purpose. Please be careful to distinguish between good merchantable oil and sediment (B. S.).

[Barrels of 42 gallons.]

| MONTHS. | TOTAL MERCHANTABLE CRUDE. | | | Total sediment (B. S.). | Total stock. |
|---|---|---|---|---|---|
| | Illuminating. | Lubricating. | Fuel oil. | | |
| 1888. | | | | | |
| December 31 | | | | | |
| 1889. | | | | | |
| January 31 | | | | | |
| February 28 | | | | | |
| March 31 | | | | | |
| April 30 | | | | | |
| May 31 | | | | | |
| June 30 | | | | | |
| July 31 | | | | | |
| August 31 | | | | | |
| September 30 | | | | | |
| October 31 | | | | | |
| November 30 | | | | | |
| December 31 | | | | | |
| Average | | | | | |

## SPECIAL SCHEDULE No. 14.—CRUDE PETROLEUM—Continued.

6. Value of stock on hand at wells December 31, 1889:
   Illuminating ...... $......
   Lubricating ...... $......
   Fuel oil ...... $......
   Total ...... $......

7. Distribution of product:
   (Under this head please give a statement as to what has become of oil produced).
   Stocks at wells December 31, 1888 ...... ......
   Produced in 1889 ...... ......
   Total ...... ......
   Stock December 31, 1889 ...... ......

Distribution in 1889:
   Delivered to pipe lines ...... ......
   Dump oil ...... ......
   Run to waste ...... ......
   Evaporated ...... ......
   Burned by lightning, fire, etc., at wells, and not included in general average of pipe lines ...... ......
   Remaining on hand December 31, 1889 ...... ......
   Total ...... ......

### LABOR AND WAGES.

8. Total number of persons employed and wages paid in 1889 ...... $......
   All labor, not including office force:
   Number of foremen or overseers ...... ......
   Total wages paid all workmen of this class in 1889 ...... $......
   Number of mechanics ...... ......
   Total wages paid all workmen of this class in 1889 ...... $......
   Number of laborers ...... ......
   Total wages paid all workmen of this class in 1889 ...... $......
   Boys under 16 years ...... ......
   Total wages paid all boys under 16 ...... $......
   Office force:
   Males—Total number ...... Total wages paid ...... $......
   Females—Total number ...... Total wages paid ...... $......

NOTE.—Where two or more groups of wells with distinct organizations, and reported on separate census schedules, are directed and paid from one central office, the employés of such central office are not to be included in the table above. Please state on the blank page opposite the total number of males and females and their total yearly earnings, together with the names of the wells with whose administration such persons are connected.

9. Wages paid for labor:
   In building rigs ...... $......
   In drilling wells ...... $......
   In operating and caring for wells ...... $......
   In torpedoing wells ...... $......
   In building or repairing tankage ...... $......
   In building and repairing pipe lines ...... $......
   In office ...... $......
   Total as above ...... $......

10. Classified wages:

NOTE.—It is earnestly desired that the following table be filled out with as much detail as possible. In the first column give the classes of employés by the name by which they are usually known, as carpenter, driller, engineer, etc.; in the second, the average number of employés of each class, and in the others, wages, earnings, etc.

| CLASSES OF EMPLOYÉS. | Number of each. | Wages when men are paid by day. | Wages per foot, etc., when men are paid by the piece. | Earnings of piece-workers. | Days employed in year. |
|---|---|---|---|---|---|
| | | | | | |

11. Was production stopped during the year? If so, for how long a period, and what was the cause? ...... ......

12. Operating and caring for wells:
   Total value of all materials used in pumping, operating, and caring for wells ...... $......

### CAPITAL.

NOTE.—In stating the amount of capital there should be included not only the amount of capital actually invested in the business, as in lands, leases, mineral rights, rights of way, private railroads, buildings, tools, and all other forms of property, but also that used in carrying on the business. This statement, to be

### SPECIAL SCHEDULE NO. 14.—CRUDE PETROLEUM—Continued.

complete, should include as capital all money borrowed, as well as accounts having a long time to run. The idea is to get returned as capital all money invested and used in the business, whether owned by the party making the return or borrowed. The value of land, fixtures, etc., should be estimated at what they are worth or would cost in 1890. If land is leased, estimate its value as oil territory as near as may be, and include amount in answer.

13. Total capital (real and personal) invested in lands, wells, leases, etc., and employed in the business .......... $......

14. Number of acres of oil land:

Owned .......... ......
Leased .......... ......

Total acreage .......... ......
Present value of land, both owned and leased .......... $......

15. Value of rigs, wells, engines, boilers, etc .......... $......
Value of tanks .......... $......
Value of tank cars .......... $......
Value of pipe lines at wells owned by party making report .......... $......
Value of oil in stock at wells, December 31, 1889 .......... $......
Value of other property and improvements .......... $......

Total .......... $......

16. Rigs:

Total number of rigs building but not completed:

December 31, 1888 .......... ......
January 31, 1889 .......... ......
February 28, 1889 .......... ......
March 31, 1889 .......... ......
April 30, 1889 .......... ......
May 31, 1889 .......... ......
June 30, 1889 .......... ......
July 31, 1889 .......... ......
August 31, 1889 .......... ......
September 30, 1889 .......... ......
October 31, 1889 .......... ......
November 30, 1889 .......... ......
December 31, 1889 .......... ......

Total value of materials used in building rigs .......... $......

Total number of rigs completed during—

January, 1889 .......... ......
February, 1889 .......... ......
March, 1889 .......... ......
April, 1889 .......... ......
May, 1889 .......... ......
June, 1889 .......... ......
July, 1889 .......... ......
August, 1889 .......... ......
September, 1889 .......... ......
October, 1889 .......... ......
November, 1889 .......... ......
December, 1889 .......... ......

Total cost of rigs built in 1889 .......... $......

17. Wells:

Total number of wells drilling:

December 31, 1888 .......... ......
January 31, 1889 .......... ......
February 28, 1889 .......... ......
March 31, 1889 .......... ......
April 30, 1889 .......... ......
May 31, 1889 .......... ......
June 30, 1889 .......... ......
July 31, 1889 .......... ......
August 31, 1889 .......... ......
September 30, 1889 .......... ......
October 31, 1889 .......... ......
November 30, 1889 .......... ......
December 31, 1889 .......... ......

Total value of materials used in drilling wells .......... $......

18. Completed wells:

In the following table please give total number of wells completed during each month in 1889, how many were dry, how many producing, and the initial daily product of new wells.

| MONTHS. | Total number of wells completed in each month. | Number of dry holes. | Number of wells producing. | Initial daily production of new wells. |
|---|---|---|---|---|
| 1889. | | | | |
| January | | | | |
| February | | | | |
| March | | | | |
| April | | | | |
| May | | | | |
| June | | | | |
| July | | | | |
| August | | | | |
| September | | | | |
| October | | | | |
| November | | | | |
| December | | | | |
| Total | | | | |

### SPECIAL SCHEDULE NO. 14.—CRUDE PETROLEUM—Continued.

19. Producing wells:

In the following table give total number of producing wells and number pumping or flowing, together with number of wells that were abandoned, that is, ceased producing during the year.

| MONTHS. | Total number producing. | Number pumping. | Number flowing. | Total number abandoned. |
|---|---|---|---|---|
| 1888. | | | | |
| December 31 | | | | |
| 1889. | | | | |
| January 31 | | | | |
| February 28 | | | | |
| March 31 | | | | |
| April 30 | | | | |
| May 31 | | | | |
| June 30 | | | | |
| July 31 | | | | |
| August 31 | | | | |
| September 30 | | | | |
| October 31 | | | | |
| November 30 | | | | |
| December 31 | | | | |
| Total | | | | |

20. If wells were abandoned, what was the cause? ..........

21. Were any wells that had ceased producing cleaned out and retubed during the year? If so, please give the number, and the result of the cleaning out....

22. Number of wells torpedoed during the year .......... ......
Cost of torpedoing .......... $......

23. Tankage:

Please give character and capacity of tankage at wells, giving size, material, and capacity of each.

| NUMBER. | SIZE. | | Material (as wood, iron, etc.). | Capacity. (Barrels of 42 gallons). |
|---|---|---|---|---|
| | Diameter. | Height. | | |
| | | | | |

24. Tankage at wells:

Total value of materials used in building or repairing tanks in 1889. $......

25. Transportation at wells:

Total value of all materials, as pipe, couplings, etc., used in building or repairing pipe lines at wells in 1889 .......... $......
Total value of all materials used in building or repairing tank cars in 1889 .......... $......

26. Pipe lines at wells:

Total length of pipe lines at wells, not including that belonging to pipe-line companies .......... feet.. ......
Total value .......... $......
Sizes of same, and length of each size ..........

NOTE.—Remarks as to the sand or other strata from which the oil is produced, depth of the wells, diameter of holes drilled, cost of drilling per running foot, character of rigs used, character of petroleum produced, special uses for which it is adapted, etc., will be gladly received, and should be included on the blank pages of this schedule.

### SPECIAL SCHEDULE NO. 15.—NATURAL GAS.

#### LOCATION.

1. Location of wells reported in this schedule:

Natural gas district, if known by any special name ..........
City, town, or township ..........
County .......... ; state ..........

NOTE.—It is desired, if parties own wells in more than one city, town, or township, that separate returns be made for each city, town, etc. When this is not possible, please report for the wells of each county separately. Additional schedules will be furnished if desired.

2. What cities, towns, or villages are supplied by you, either in whole or in part, with natural gas? ..........

3. Name and post-office address of company, corporation, or individual operating the wells ..........

## SPECIAL SCHEDULE NO. 15.—NATURAL GAS—Continued.

### PRODUCTION.

NOTE.—Please give as complete and exact statements as possible regarding production during the year 1889. It is conceded that this will be difficult to do, but it is hoped that as exact an answer as is possible will be given to the following questions:

4. Total production of wells during the year ending December 31, 1889, cubic feet ........................................................................ ......
Amount consumed in useful work............cubic feet............ ......
Went to waste..................................cubic feet............ ......

The amount consumed in useful work was distributed as follows:

| | NO. OF FIRES. | CUBIC FEET CONSUMED. |
|---|---|---|
| Domestic uses.................................... | ............ | ............ |
| | NO. OF WORKS SUPPLIED. | |
| Iron rolling mills .................................. | ............ | ............ |
| Steel works ......................................... | ............ | ............ |
| Glass works.......................................... | ............ | ............ |
| Other establishments................................ | ............ | ............ |

5. Value of gas produced and used:

NOTE.—In answering this question the best measure of the value of gas produced is the actual amount charged consumers. Where gas is given away, as is the case in many localities, estimate the value of the gas used by the parties receiving it gratis. The best way to reach this value, when but little gas is sold, is to estimate how much coal or wood would be used to do the work; that is, to supply the same number of fires, to make the same amount of iron or glass, to fire the same number of boilers, etc., and regard the value of this coal as the value of the gas.

Total actual selling price or value, as estimated above, of all gas produced and used for the year ending December 31, 1889........ $......
How much coal would have been required to do the same work..tons......
What would have been the value of this coal...................... $......

### LABOR AND WAGES.

6. Total number of persons employed and total wages paid in 1889:
Number (*a*)..............................; total wages (*b*) ......... $......
Details of above:
Number of foremen or overseers............................... ......
Total wages paid to all workmen of this class in 1889......... $......
Number of mechanics ........................................ ......
Total wages paid to all workmen of this class in 1889......... $......
Number of laborers (*c*) ...................................... ......
Total wages paid to all workmen of this class in 1889......... $......
Number of boys under 16 years................................ ......
Total wages paid to all boys in 1889 ........................... $......
Office force: (*d*)
Males............total number............; total wages........ $......
Females .........total number............; total wages........ $......

---

*a* In giving the number of men employed include those employed by contractors and subcontractors, as well as by the company itself.

*b* Wages must include value of board or rent furnished as part compensation.

*c* Laborers include watchmen, teamsters, and all workmen not otherwise classified in the schedule.

*d* Where two or more groups of wells with distinct organizations, and reported on separate census schedules, are directed and paid from one central office, the employés of such central office are not to be included in the table above. Please state on the blank page opposite the total number of males and females and their total yearly earnings, together with the names of the wells with whose administration such persons are connected.

### RATES OF WAGES.

7. Class of employés:

It is earnestly desired that the following table be filled out with as much detail as possible. In the first column give the classes of employés by the name by which they are usually known, as carpenter, driller, engineer, etc. Include not only men at wells, but pipe-line and station men, valve men, fitters, etc.

| CLASSES OF EMPLOYÉS. | Number of each class. | Wages where men are paid by the day. | Wages per foot, etc., where men are paid by the piece. | Earnings of piece-workers. | Days employed in year. |
|---|---|---|---|---|---|
| .................... | ............ | ............ | ............ | ............ | ............ |

## SPECIAL SCHEDULE NO. 15.—NATURAL GAS—Continued.

8. Was drilling stopped during the year? If so, for how long a period, and what was the cause?....................................................................
9. Was production stopped during the year? If so, for how long a period, and what was the cause? ................................................................

### CAPITAL.

NOTE.—In stating the amount of capital there should be included not only the amount of capital actually invested in the business, as in lands, leases, mineral rights, rights of way, private railroads, buildings, tools, and all other forms of property, but also that used in carrying on the business. This statement, to be complete, should include as capital all money borrowed as well as accounts having a long time to run. The idea is to get returned as capital all money invested and used in the business, whether owned by the party making the return or borrowed. The value of lands, leases, gas rights, wells, pipe lines, and all real and other property, should be estimated at what they are worth or would cost in 1890. If land is leased, estimate its value as gas territory, as near as may be, and include this value in answer. These questions are intended to get at the value of property, which may be more or less than capital.

10. Total capital invested in lands, wells, pipe lines, etc., and used in business ............................................................ $......
Number of acres of natural gas land:
Owned ................................................ ......
Leased ................................................ ......

Total acreage ........................................ ......

Present value of land, both owned and leased.................. $......
Value of rigs, wells, engines, boilers, etc......................... $......
Value of pipe lines, including rights of way ..................... $......
Value of all other property and improvements................. $......

Total............................................................ $......

11. Wells:
Total number of wells drilling:
December 31, 1888 ...... ......
January 31, 1889 ...... ......
February 28, 1889 ...... ......
March 31, 1889 ........ ......
April 30, 1889 .......... ......
May 31, 1889............ ......
June 30, 1889 ........... ......
July 31, 1889.................. ......
August 31, 1889............... ......
September 30, 1889........... ......
October 31, 1889.............. ......
November 30, 1889 ........... ......
December 31, 1889 ........... ......

### COMPLETED WELLS.

In the following table please give total number of wells completed during each month in 1889, how many were dry, how many producing, the initial pressure, and estimated daily production of new wells.

| MONTHS. | Total number of wells completed in each month. | Number of dry holes. | Number of wells producing. | Initial pressure of new wells. | Estimated daily production of new wells. |
|---|---|---|---|---|---|
| 1889. | | | | Pounds. | Cubic feet. |
| January .......... | .......... | .......... | .......... | .......... | .......... |
| February .......... | .......... | .......... | .......... | .......... | .......... |
| March .......... | .......... | .......... | .......... | .......... | .......... |
| April .......... | .......... | .......... | .......... | .......... | .......... |
| May .......... | .......... | .......... | .......... | .......... | .......... |
| June .......... | .......... | .......... | .......... | .......... | .......... |
| July .......... | .......... | .......... | .......... | .......... | .......... |
| August .......... | .......... | .......... | .......... | .......... | .......... |
| September .......... | .......... | .......... | .......... | .......... | .......... |
| October .......... | .......... | .......... | .......... | .......... | .......... |
| November .......... | .......... | .......... | .......... | .......... | .......... |
| December .......... | .......... | .......... | .......... | .......... | .......... |
| Total .......... | .......... | .......... | .......... | .......... | .......... |

State if pressure was closed or flowing.................................... ......

Total cost of drilling wells in 1889, including cost of rigs, drive-pipe, casing, and tubing ..................................................... $......
Of this total cost state—
The amount of wages paid labor ..................................... $......
Cost of material........................................................ $......

### SPECIAL SCHEDULE No. 15.—NATURAL GAS—Continued.

#### PRODUCING WELLS.

In the following table give total number of producing wells, together with number of wells that were abandoned, that is, ceased producing during the year:

| MONTHS. | Total number producing. | Total number abandoned. |
|---|---|---|
| 1888. | | |
| December 31 | | |
| 1889. | | |
| January 31 | | |
| February 28 | | |
| March 31 | | |
| April 30 | | |
| May 31 | | |
| June 30 | | |
| July 31 | | |
| August 31 | | |
| September 30 | | |
| October 31 | | |
| November 30 | | |
| December 31 | | |
| | Average | Total |

If wells were abandoned, what was the cause?

Were any wells that had ceased producing cleaned out and retubed during the year? If so, please give number and the result of cleaning out

Number of wells torpedoed during year. Cost of torpedoing $

12. Pressure:

Please give such facts relative to well pressure as may be of interest, especially with reference to the flowing and closed pressure of the wells when first struck, and statements as to changes in this pressure during the year.

13. Charges to consumers:

Please give below rates charged to consumers for gas. If you have printed tables of rates, please inclose copies, stating whether these are adhered to or discounted. Make the answer as full and complete as possible.

14. Pipe lines:

In the following table give number of feet of each size of pipe laid prior to January 1, 1889, and up to and including December 31, 1889:

| SIZE OF PIPE. (Inches.) | Total number of feet laid prior to January 1, 1889. | Total number of feet laid up to and including December 31, 1889. | Size of pipe. (Inches.) | Total number of feet laid prior to January 1, 1889. | Total number of feet laid up to and including December 31, 1889. |
|---|---|---|---|---|---|
| | | | | | |

15. Materials used:

Total value of materials used in building rigs $

Total value of materials used in drilling wells $

Total value of all materials used in operating, shutting in, and caring for wells $

Total value of all materials, as pipe, couplings, etc., used in building or repairing pipe lines in 1889 $

Total value of all materials used in fitting $

Number of torpedoes used; value $

Total value of all other materials $

16. Exhaustion of district:

Please give such facts as you may have relative to the giving out of wells, reduction of pressure, etc., that will bear upon the question of the exhaustion of gas in your district.

NOTE.—Remarks as to the sand or other strata from which the gas is produced, depth of wells, diameter of holes drilled, cost of drilling per running foot, character of rigs used, character of gas produced, character of petroleum accompanying the gas, special uses for which the gas is adapted, etc., will be gladly received, and should be included on the blank pages of this schedule.

#### PETROLEUM PRODUCED.

17. Product by months:

(If you produced any petroleum from gas wells during the year please fill out the table below. A separate schedule will be sent if you have petroleum wells as well as gas wells.)

### SPECIAL SCHEDULE No. 15.—NATURAL GAS—Continued.

[Barrels of 42 gallons.]

| MONTHS. | Crude for illuminating. | Crude for lubricating. | Fuel oil. | Total. |
|---|---|---|---|---|
| 1889. | | | | |
| January | | | | |
| February | | | | |
| March | | | | |
| April | | | | |
| May | | | | |
| June | | | | |
| July | | | | |
| August | | | | |
| September | | | | |
| October | | | | |
| November | | | | |
| December | | | | |
| Total | | | | |

18. Total value at wells of all oil produced, excluding pipage:

Illuminating $

Lubricating $

Fuel oil $

Total $

19. Stocks at well:

NOTE.—In this table give only stocks at wells, not including any stocks that may be held by you in pipe lines and represented by certificates. If you have a pipe line and tanks away from wells for your exclusive use, make report of same on schedule that will be furnished for that purpose. Please be careful to distinguish between good merchantable oil and sediment (B. S.).

[Barrels of 42 gallons.]

| MONTHS. | Total merchantable crude. (Illuminating.) | Total merchantable crude. (Lubricating.) | Total merchantable crude. (Fuel oil.) | Total sediment. (B. S.) | Total stock. |
|---|---|---|---|---|---|
| 1888. | | | | | |
| December 31 | | | | | |
| 1889. | | | | | |
| January 31 | | | | | |
| February 28 | | | | | |
| March 31 | | | | | |
| April 30 | | | | | |
| May 31 | | | | | |
| June 30 | | | | | |
| July 31 | | | | | |
| August 31 | | | | | |
| September 30 | | | | | |
| October 31 | | | | | |
| November 30 | | | | | |
| December 31 | | | | | |
| Average | | | | | |

20. Value of stock on hand at wells December 31, 1889:

Illuminating $

Lubricating $

Fuel oil $

Total $

21. Distribution of product:

(Under this head please give a statement as to what has become of oil produced.)

Stock at wells December 31, 1888

Produced in 1889

Total

Distribution:

Delivered to pipe lines

Dump oil

Run to waste

Evaporated

Burned by lightning, fire, etc., at wells, and not included in general average of pipe lines

Remaining on hand December 31, 1889

Total

## SPECIAL SCHEDULE No. 15.—NATURAL GAS—Continued.

### TANKAGE.

22. Please give character and capacity of tankage at wells, giving size, material, and capacity of each.

| NUMBER. | SIZE. | | Material (as wood, iron, etc.). | Capacity. (Barrels of 42 gallons.) |
|---|---|---|---|---|
| | Diameter. | Height. | | |
| ........ | ........ | ........ | ........ | ........ |

Total value of tankage ........ $......
How many tank cars are owned by you and used in the freighting of crude petroleum? ........ ......
Value of same ........ $......

## SPECIAL SCHEDULE No. 16.—STONE QUARRIES.

### LOCATION.

1. Name of quarry ........
2. Location of quarry:
    District or region ........
    County ........
    State ........
3. Name and post-office address of company, corporation, or individual operating the quarry ........
4. Name and post-office address of resident superintendent or agent ........
5. Character of stone produced:
    Popular name (*a*) ........
    Scientific name ........
    Purposes for which the product is used ........

*a* Give, as the popular name, that under which the stone is sold.

### PRODUCT.

NOTE.—Use the cubic foot, cubic yard, perch, long or short ton, or whatever unit you customarily employ, but state distinctly which you use. If any calculations are made, such as determining the total value of the product from the prices received, it is requested that such calculations be made on the blank pages of this schedule, which may also be used for remarks and explanations of answers to the questions.

6. Total product of stone of all grades during the year ended December 31, 1889:
........
    Amounts applied to each of the different uses:
........
7. Total value of the above product: ........ $......

NOTE.—This is determined by the selling price at the quarry, of whatever products the operator disposes of, whether rough or manufactured.

### LABOR AND WAGES.

| CLASSIFICATION. | Average number employed. (*a*) | Average wages per day. (*b*) | Average number of days' work made by each class during the year. |
|---|---|---|---|
| 8. Labor (not including office force): | | | |
| Foremen or overseers ........ | ........ | ........ | ........ |
| Quarrymen ........ | ........ | ........ | ........ |
| Mechanics ........ | ........ | ........ | ........ |
| Laborers (*c*) ........ | ........ | ........ | ........ |
| Boys under 16 ........ | ........ | ........ | ........ |

*a* In giving the number of men employed include those employed by contractors and subcontractors, as well as by the company itself.

*b* Wages must include value of board or rent furnished as part compensation.

*c* Laborers include watchmen, teamsters, and all workmen not otherwise classified.

9. Wages:
    Total amount of wages paid above during 1889 ........ $......
    Total amount paid to contractors for contract work done in 1889, not included in the above item, deducting supplies charged to them . $......
10. Office force at quarries or works: (*d*)
    Males ........ No. ...... $......
    Females ........ No. ...... $......
    Grand total of wages ........ $......

## SPECIAL SCHEDULE No. 16.—STONE QUARRIES—Continued.

*d* Where two or more quarries with distinct organizations, and reported on separate census schedules, are directed and paid from one central office, the employés of such central office are not to be included in the table above. Please state on the blank page opposite the total number of males and females and their total yearly earnings, together with the names of the quarries with whose administration such persons are connected.

11. Number of days during the year when the quarries or works were idle, and the cause ........

### CAPITAL.

12. Total value of quarries and improvements as at present developed... $......
    Distributed as follows:
    In land ........ $......
    In buildings and fixtures ........ $......
    In tools, implements, live stock, machinery, and supplies on hand ........ $......
    In cash (not reported in the foregoing items) ........ $......

NOTE.—In stating the amount of capital there should be included not only the amount of capital actually invested in the business, as in lands, leases, mineral rights, rights of way, private railroads, buildings, tools, and all other forms of property, but also that used in carrying on the business. This statement, to be complete, should include as capital all money borrowed, as well as accounts having a long time to run. The idea is to get returned as capital all money invested and used in the business, whether owned by the party making the return or borrowed. The value of land, fixtures, etc., should be estimated at what they are worth or would cost in 1890.

13. Power used:
    Number and total horse power of steam boilers..No....; horse power......
    Number and size of cylinders of steam engines ........
    If other power, state kind ........
    Number of motors ........; horse power ........
14. Number of animals employed ........
15. Total value of supplies and materials of all kinds consumed during the year 1889 ........ $......
16. Total of all other expenditures for the quarries (including amounts paid for rent, taxes, insurance, interest, etc.) ........ $......

NOTE.—Remarks showing the uses for which your product has proved especially valuable, tests of strength, analyses, etc., will be gladly received and should be made upon the blank pages of this schedule.

## SPECIAL SCHEDULE No. 17.—MINERAL WATERS.

### LOCATION.

1. Name of springs ........
    Former name, if the springs have ever been known by any other name ..
2. Location of springs ........
    County ........
    State ........
3. Name and post-office address of company, corporation, or individual operating the springs ........
4. Name and post-office address of resident superintendent or agent ........
5. Total number of individual springs ........
6. Is the water on sale in the market? ........
7. Number of springs from which water is taken for sale ........
8. Total capacity of springs used commercially ........
9. Are the springs used as a resort? ........
10. Character of springs ........
11. Analysis ........
12. Date of analysis ........
13. Name of analyst ........
14. How is the water shipped? (Bottled or barreled) ........

### PRODUCT.

15. Total product for the year ended December 31, 1889: (Estimate if no account is kept.)
    Number of gallons sold ........ ......
    Number of barrels sold ........ ......

NOTE.—Give the above amount in gallons, if possible; if barrels are used, state their capacity and number. If the water is evaporated, and only the mass or evaporated material is sold, state its amount and fill in the number of gallons evaporated.

16. Average price per gallon at the springs ........ $......
17. Total value of the product sold, determined by the selling price at the springs, or wherever the water is disposed of ........ $......

### SPECIAL SCHEDULE No. 17.—MINERAL WATERS—Continued.

#### LABOR AND WAGES.

| CLASSIFICATION. | Average number employed. (a) | Average wages per day. (b) | Average number of days' work made by each class during the year. |
|---|---|---|---|
| 18. Labor (not including office force): | | | |
| Foremen or overseers | | | |
| Mechanics | | | |
| Laborers (c) | | | |
| Boys under 16 | | | |

*a* In giving the number of men employed include those employed by contractors and subcontractors, as well as by the company itself.

*b* Wages must include value of board or rent furnished as part compensation.

*c* Laborers include watchmen, teamsters, and all workmen not otherwise classified in the schedule.

19. Wages:
  Total amount of wages paid above during 1889 ...................... $.....
  Total amount paid to contractors for contract work done in 1889, not included in the above item, deducting supplies charged to them ...................... $.....

20. Office force at springs: (*d*)
  Males ...................... No........ $.....
  Females ...................... No........ $.....
  Grand total of wages ...................... $.....

*d* Where two or more springs with distinct organizations, and reported on separate census schedules, are directed and paid from one central office, the employés of such central office are not to be included in the table above. Please state on the blank page opposite the total number of males and females and their total yearly earnings, together with the names of the springs with whose administration such persons are connected.

21. Number of days during the year when no work was done at springs, and the cause ......................

#### CAPITAL.

22. Total capital (real and personal) invested in lands, leases, improvements, etc., and employed in business ...................... $.....
  Distributed as follows:
    In land ...................... $.....
    In buildings and fixtures ...................... $.....
    In tools, implements, live stock, machinery, and supplies on hand ...................... $.....
    In cash (including all capital not reported in the foregoing items) ...................... $.....

NOTE.—In stating the amount of capital there should be included not only the amount of capital actually invested in the business, as in lands, leases, water rights, rights of way, buildings, tools, and all other forms of property, but also that used in carrying on the business. This statement, to be complete, should include as capital all money borrowed, as well as accounts having a long time to run. The idea is to get returned as capital all money invested and used in the business, whether owned by the party making the return or borrowed. The value of land, fixtures, etc., should be estimated at what they are worth or would cost in 1890.

23. Power used:
  Number and total horse power of steam boilers...No....; horse power.....
  Number and size of cylinders of steam engines ...................... ......
  If other power, state kind ...................... ......
  Number of motors ......................; horse power ............ ......

24. Number of animals employed ...................... ......

25. Total value of supplies and materials of all kinds consumed during the year 1889 ...................... $.....

26. Total of all other expenditures for the springs (including amounts paid for rent, taxes, insurance, interest, etc.) ...................... $.....

### SPECIAL SCHEDULE No. 19.—LEAD SMELTERS AND REFINERS.

#### LOCATION.

1. Name of works ......................

2. Location of works:
  Town ......................
  County ......................
  State ......................

### SPECIAL SCHEDULE No. 19.—LEAD SMELTERS AND REFINERS—Cont'd.

3. Name and post-office address of company, corporation, or individual operating the works ......................

4. Name and post-office address of resident superintendent or agent ............

#### PRODUCT.

NOTE.—If any calculations are made, such as determining the total value of the product, it is requested that such calculations be made on the blank pages of this schedule. These blank pages may also be used for any remarks explanatory of the answers given.

5. Total product of base bullion in the year ended December 31, 1889 (net tons of 2,000 pounds) ...................... ......

6. Total stock of base bullion on hand or in transit:
  January 1, 1889 (net tons of 2,000 pounds) ...................... ......
  January 1, 1890 (net tons of 2,000 pounds) ...................... ......

7. Quantity of ore treated ...................... ......

8. Total value of ore treated ...................... $.....

#### LABOR AND WAGES.

| CLASSIFICATION. | Average number employed. (a) | Average wages per day. (b) | Average number of days' work made by each class during the year. |
|---|---|---|---|
| 9. Labor (not including office force): | | | |
| Foremen or overseers | | | |
| Mechanics | | | |
| Laborers (c) | | | |
| Boys under 16 | | | |

*a* In giving the number of men employed include those employed by contractors and subcontractors, as well as by the company itself.

*b* Wages must include value of board or rent furnished as part compensation.

*c* Laborers include watchmen, teamsters, and all workmen not otherwise classified.

10. Wages:
  Total amount of wages paid above during 1889 ...................... $.....
  Total amount paid to contractors for contract work done in 1889, not included in the above item, deducting supplies charged to them.. $.....

11. Office force at works: (*d*)
  Males ...................... No............ $.....
  Females ...................... No............ $.....
  Total ...................... $.....

*d* Where two or more works with distinct organizations, and reported on separate census schedules, are directed and paid from one central office, the employés of such central office are not to be included in the table above. Please state on the blank page opposite the total number of males and females and their total yearly earnings, together with the names of the works with whose administration such persons are connected.

12. Number of days during the year when the works were idle, and the cause ....

#### CAPITAL.

13. Total value of works and improvements as at present developed...... $.....
  Distributed as follows:
    In land ...................... $.....
    In buildings and fixtures ...................... $.....
    In tools, implements, live stock, machinery, and supplies on hand ...................... $.....
    In cash (including all capital not reported in the foregoing items). $.....

NOTE.—In stating the amount of capital there should be included not only the amount of capital actually invested in the business, as in lands, leases, mineral rights, rights of way, private railroads, buildings, tools, and all other forms of property, but also that used in carrying on the business. This statement, to be complete, should include as capital all money borrowed, as well as accounts having a long time to run. The idea is to get returned as capital all money invested and used in the business, whether owned by the party making the return or borrowed. The value of land, fixtures, etc., should be estimated at what they are worth or would cost in 1890.

14. Power used:
  Number and total horse power of steam boilers..No....; horse power......
  Number and size of cylinders of steam engines ...................... ......
  If other power, state kind ...................... ......
  Number of motors ......................; horse power ............ ......

15. Number of animals employed ...................... ......

16. Total value of supplies and materials consumed during the year 1889, exclusive of value of ore ...................... $.....

17. Total of all other expenditures for the works (including amounts paid for rent, taxes, insurance, interest, etc.) ...................... $.....

## SPECIAL SCHEDULE No. 20.—LEAD REFINERS.

### LOCATION.

1 Name of works ........................................

2. Location of works:

Town ........................................

County ........................................

State ........................................

3. Name and post-office address of company, corporation, or individual operating the works ........................................

4. Name and post-office address of resident superintendent or agent ..............

### PRODUCT.

NOTE.—If any calculations are made, such as determining the total value of the product, it is requested that such calculations be made on the blank pages of this schedule. These blank pages may also be used for any remarks explanatory of the answers given.

5. Total product of refined lead in the year ended December 31, 1889, (net tons of 2,000 pounds) ........................................ ......

6. Total stock of refined lead on hand, in transit, and unsold in hands of agents:

January 1, 1889 (net tons of 2,000 pounds) ............................ ......

January 1, 1890 (net tons of 2,000 pounds) ............................ ......

7. Copper contents of matte or refined copper produced (pounds fine) .... ......

### LABOR AND WAGES.

| CLASSIFICATION. | Average number employed. (*a*) | Average wages per day. (*b*) | Average number of days' work made by each class during the year. |
|---|---|---|---|
| 8. Labor (not including office force): | | | |
| Foremen or overseers .......... | .............. | .............. | .............. |
| Mechanics .......... | .............. | .............. | .............. |
| Laborers (*c*) .......... | .............. | .............. | .............. |
| Boys under 16 .......... | .............. | .............. | .............. |

*a* In giving the number of men employed include those employed by contractors and subcontractors, as well as by the company itself.

*b* Wages must include value of board or rent furnished as part compensation.

*c* Laborers include watchmen, teamsters, and all workmen not otherwise classified.

9. Wages:

Total amount of wages paid above during 1889 .......................... $......

Total amount paid to contractors for contract work done in 1889, not included in the above item, deducting supplies charged to them ........................................ $......

10. Office force at works: (*d*)

Males ........................................ No.... $......

Females ........................................ No.... $......

Grand total of wages ........................................ $......

*d* Where two or more works with distinct organizations, and reported on separate census schedules, are directed and paid from one central office, the employés of such central office are not to be included in the table above. Please state on the blank page opposite the total number of males and females and their total yearly earnings, together with the names of the works with whose administration such persons are connected.

11. Number of days during the year when the works were idle, and the cause....

### CAPITAL.

12. Total value of works and improvements as at present developed ..... $......

Distributed as follows:

In land ........................................ $......

In buildings and fixtures ........................................ $......

In tools, implements, live stock, machinery, and supplies on hand ........................................ $......

In cash (not reported in the foregoing items) .............................. $......

NOTE.—In stating the amount of capital there should be included not only the amount of capital actually invested in the business, as in lands, leases, mineral rights, rights of way, private railroads, buildings, tools, and all other forms of property, but also that used in carrying on the business. This statement, to be complete, should include as capital all money borrowed, as well as accounts having a long time to run. The idea is to get returned as capital all money invested and used in the business, whether owned by the party making the return or borrowed. The value of land, fixtures, etc., should be estimated at what they are worth or would cost in 1890.

13. Power used:

Number of total horse power of steam boilers... No. .....; horse power.....

Number and size of cylinders of steam engines ...................... ......

If other power, state kind ........................................ ......

Number of motors ........................; horse power .............. ......

## SPECIAL SCHEDULE No. 20.—LEAD REFINERS—Continued.

14. Number of animals employed ........................................ ......

15. Total value of supplies and materials of all kinds consumed during the year 1889, exclusive of matte, base bullion, or other source from which lead was refined ........................................ $......

16. Total of all other expenditures for the works (including amounts paid for rent, taxes, insurance, interest, etc.) ............................ $......

## SPECIAL SCHEDULE No. 21.—ZINC REDUCTION WORKS.

### LOCATION.

1. Name of works ........................................

2. Location of works:

Town ........................................

County ........................................

State ........................................

3. Name and post-office address of company, corporation, or individual operating the works ........................................

4. Name and post-office address of resident superintendent or agent ..............

### PRODUCT.

NOTE.—If any calculations are made, such as determining the total value of the product, it is requested that such calculations be made on the blank pages of this schedule. These blank pages may also be used for any remarks explanatory of the answers given.

5. Total product of spelter or zinc in the year ended December 31, 1889 (net tons of 2,000 pounds) ........................................

6. Total stock of spelter or zinc on hand, in transit, and unsold in hands of agents:

January 1, 1889 (net tons of 2,000 pounds) ............................ ......

January 1, 1890 (net tons of 2,000 pounds) ............................ ......

7. Total quantity of ore treated ........................................ ......

8. Total value of ore treated ........................................ $......

### LABOR AND WAGES.

| CLASSIFICATION. | Average number employed. (*a*) | Average wages per day. (*b*) | Average number of days' work made by each class during the year. |
|---|---|---|---|
| 9. Labor (not including office force): | | | |
| Foreman or overseers .......... | .............. | .............. | .............. |
| Mechanics .......... | .............. | .............. | .............. |
| Laborers (*c*) .......... | .............. | .............. | .............. |
| Boys under 16 .......... | .............. | .............. | .............. |

*a* In giving the number of men employed include those employed by contractors and subcontractors, as well as by the company itself.

*b* Wages must include value of board or rent furnished as part compensation.

*c* Laborers include watchmen, teamsters, and all workmen not otherwise classified.

10. Wages:

Total amount of wages paid above during 1889 .......................... $......

Total amount paid to contractors for contract work done in 1889, not included in the above item, deducting supplies charged to them .. $......

11. Office force at works: (*d*)

Males ........................................ No.... $......

Females ........................................ No.... $......

Grand total of wages ........................................ $......

*d* Where two or more works with distinct organizations, and reported on separate census schedules, are directed and paid from one central office, the employés of such central office are not to be included in the table above. Please state on the blank page opposite the total number of males and females and their total yearly earnings, together with the names of the works with whose administration such persons are connected.

12. Number of days during the year when the works were idle, and the cause....

### CAPITAL.

13. Total value of works as at present developed .......................... $......

Distributed as follows:

In land ........................................ $......

In buildings and fixtures ........................................ $......

In tools, implements, live stock, machinery, and supplies on hand ........................................ $......

In cash (not reported in the foregoing items) .............................. $......

NOTE.—In stating the amount of capital there should be included not only the amount of capital actually invested in the business, as in lands, leases, mineral rights, rights of way, private railroads, buildings, tools, and all other forms of property, but also that used in carrying on the business. This statement, to be

SPECIAL SCHEDULE NO. 21.—ZINC REDUCTION WORKS—Continued.

complete, should include as capital all money borrowed, as well as accounts having a long time to run. The idea is to get returned as capital all money invested and used in the business, whether owned by the party making the return or borrowed. The value of land, fixtures, etc., should be estimated at what they are worth or would cost in 1890.

14. Power used:
Number and total horse power of steam boilers ..No....; horse power......
Number and size of cylinders of steam engines...................... ......

SPECIAL SCHEDULE NO. 21.—ZINC REDUCTION WORKS—Continued.

14. Power used—continued.
If other power, state kind........................................... ......
Number of motors .....................; horse power............. ......
15. Number of animals employed ........................................ ......
16. Total value of supplies and materials of all kinds consumed during the year 1889, exclusive of value of ore .................................. $......
17. Total of all other expenditures for the works (including amounts paid for rent, taxes, insurance, interest, etc.)............................ $......

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